This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

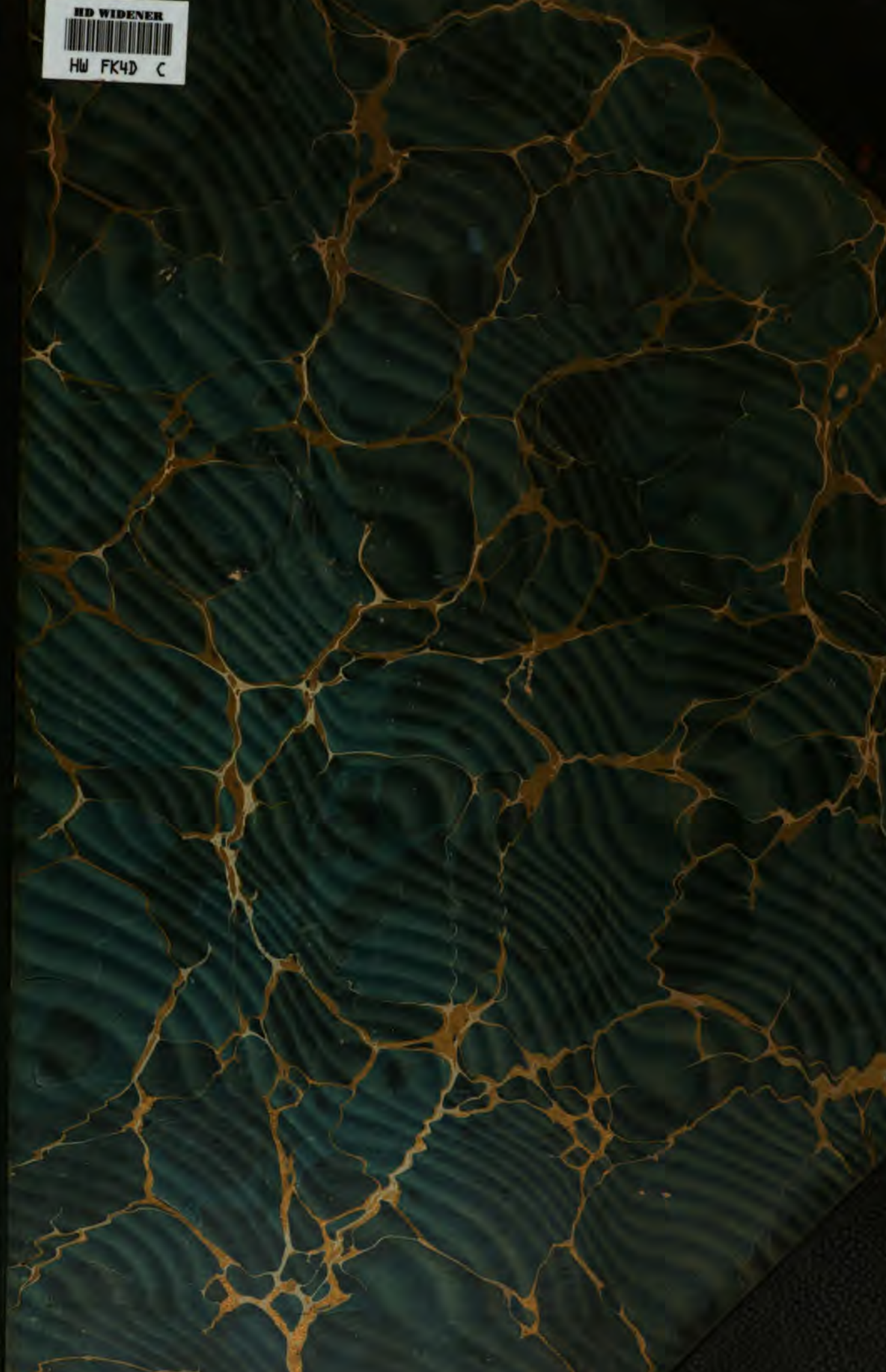
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

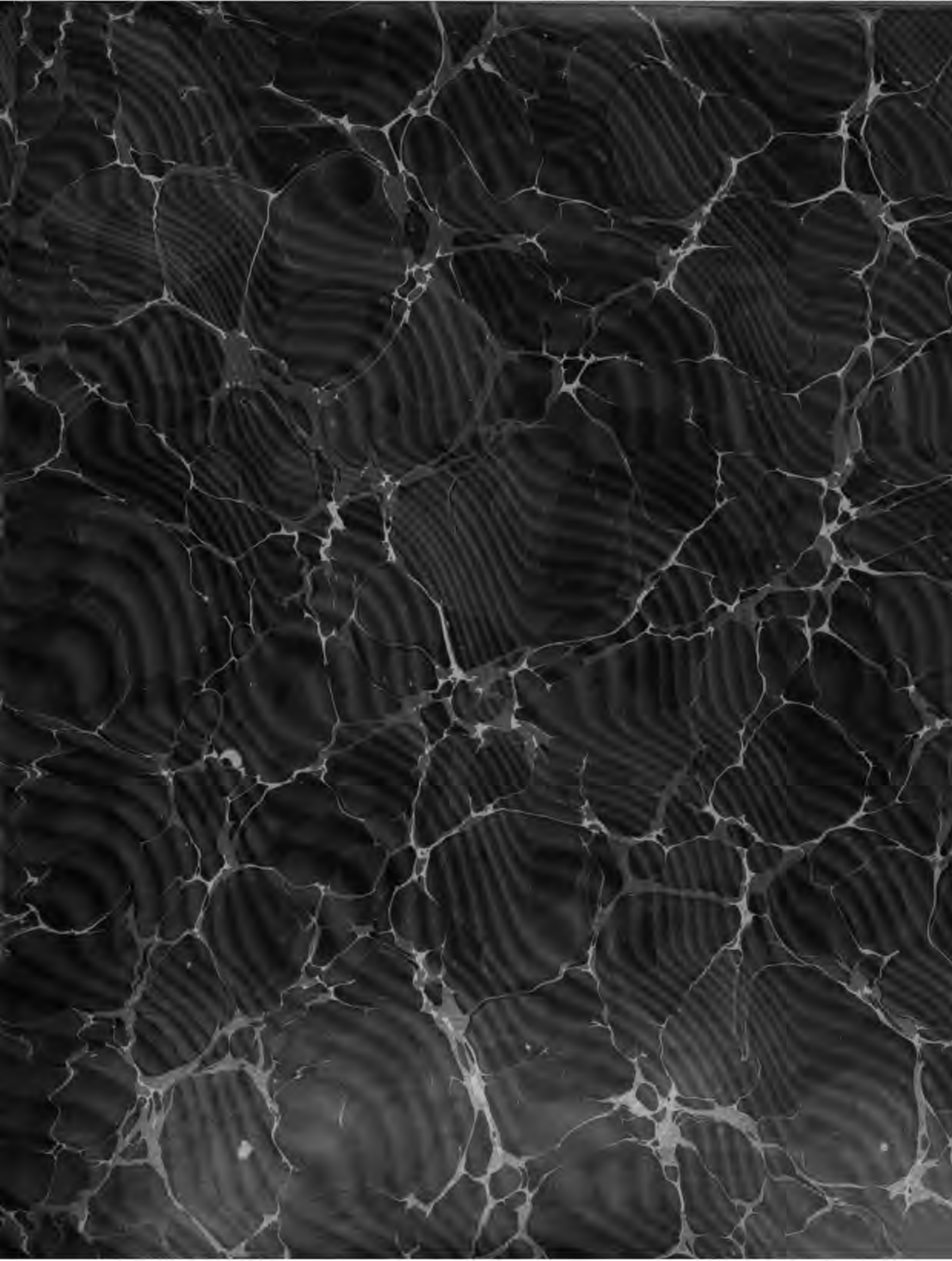
Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

5810
2

HD WIDENER
HW FK4D C



HARVARD·COLLEGE·LIBRARY
GIFT·OF
DANIEL·B·FEARING
CLASS·OF·1882 · : · A·M·1911
OF·NEWPORT
·1915·
THIS·BOOK·IS·NOT·TO·BE·SOLD·OR·EXCHANGED



A.HILCKEN
EWPORT.R.I.

[SEPTEMBER, 1895.]

THE

SCIENTIFIC TRANSACTIONS

OF THE

ROYAL DUBLIN SOCIETY.

VOLUME V. (SERIES II.)

IX.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890-1891. REPORT ON THE RARER FISHES.

By ERNEST W. L. HOLT, AND W. L. CALDERWOOD, F.R.S.E.

PLATES XXXIX. TO XLIV.

DUBLIN:
PUBLISHED BY THE ROYAL DUBLIN SOCIETY.
WILLIAMS AND NORGATE,
14, HENRIETTA STREET, COVENT GARDEN, LONDON;
20, SOUTH FREDERICK STREET, EDINBURGH; AND 7, BROAD STREET, OXFORD.
PRINTED AT THE UNIVERSITY PRESS, BY PONSONBY AND WELDRICK.
1895.

Price Eight Shillings.

Holt, E. W. L. and W. L. **Calderwood.** Report on the rarer Fishes (west Coast of Ireland). (1895.) 4. W. 6 pl. Nec' 09 8. —

[SEPTEMBER, 1895.]

THE

SCIENTIFIC TRANSACTIONS

OF THE

ROYAL DUBLIN SOCIETY.

VOLUME V. (SERIES II.)

IX.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890-1891. REPORT ON THE RARER FISHES.

By ERNEST W. L. HOLT, AND W. L. CALDERWOOD, F.R.S.E.

PLATES XXXIX. TO XLIV.

DUBLIN:
PUBLISHED BY THE ROYAL DUBLIN SOCIETY.
WILLIAMS AND NORGATE,
14, HENRIETTA STREET, COVENT GARDEN, LONDON;
20, SOUTH FREDERICK STREET, EDINBURGH; AND 7, BROAD STREET, OXFORD.
PRINTED AT THE UNIVERSITY PRESS, BY PONSONBY AND WELDRICK.
1895.

F 5810.2

SYSTEMATIC LIST OF SPECIES,*

SEPARATED INTO "LITTORAL" AND "DEEP-SEA" GROUPS, BY CAPTURE ABOVE OR BELOW THE 100 FATHOM LINE; GREATEST DEPTH, IN THIS INSTANCE, BEING 500 FATHOMS.

LITTORAL.

ELASMOBRANCHII:

Raia maculata.
Raia blanda.
Raia microcellata.

TELEOSTEI:

Gobius Friesii.
Aphia pellucida.

TELEOSTEI:

Crystallogobius Nilssonii.
Callionymus maculatus.
Gadus merlangus.
Rhombus norvegicus.
Arnoglossus laterna.
Arnoglossus Grohmanni.

DEEP-SEA.

ELASMOBRANCHII.

Chimæra monstrosa.
Galeus vulgaris.
Scyllium canicula.
Pristiurus melanostoma.
Acanthias vulgaris.
Centrophorus squamosus.
Raia batis.
Raia oxyrhynchus.
Raia fullonica.
Raia circularis.

TELEOSTEI:

Pomatomus telescopium.
Scorpæna dactyloptera.
Hoplostethus mediterraneum.
Lepidopus caudatus.
Trichiurus lepturus.
Echeneis remora.
Capros aper.
Schedophilus medusophagus.
Cottus quadricornis.
Trigla cuculus.
Trigla lyra.
Lophius piscatorius.
Liparis vulgaris.
Carelophus Ascanii.
Trachypterus arcticus.
Gobius Jeffreysii.
Callionymus lyra.

TELEOSTEI:

Gadus morrhua.
Gadus æglefinus.
Gadus poutassou.
Gadus Esmarkii.
Gadus argenteus.
Mora mediterranea.
Merluccius vulgaris.
Phycis Aldrichii.
Phycis blennioides.
Haloporphyrus eques.
Molva vulgaris.
Motella cimbria.
Motella tricirrata.
Brosmius brosme.
Macrurus cælorhynchus.
Macrurus rupestris.
Macrurus æqualis.
Macrurus lævis.
Hippoglossus vulgaris.
Hippoglossoides platessoides.
Rhombus megastoma.
Rhombus Boscii.
Pleuronectes cynoglossus.
Solea vulgaris.
Solea Greenii.
Solea variegata.
Argentina sphyræna.
Conger vulgaris.
Nettophichthys retropinnatus.

* For Alphabetic List of Species, see p. 512.

HARVARD COLLEGE LIBRARY
GIFT OF
DANIEL B. FEARING
30 JUNE 1915

IX.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890-1891. REPORT ON THE RARER FISHES.

By ERNEST W. L. HOLT, and W. L. CALDERWOOD, F.R.S.E.

(Plates XXXIX. to XLIV.)

(communicated by the fishery committee.)

[Read December 16, 1891.*]

INTRODUCTION.

Reports, already published, giving results of fishing operations, have dealt with the commoner forms found during the Survey, and scientific evidence upon economic questions.

A preliminary series of notes has also been published concerning the occurrence of the rarer forms, and, in addition, these have been very briefly dealt with in the reports already alluded to.

In the present Paper we propose to deal with the rarer forms in greater detail, more especially with regard to their structure and affinities, the whole being introduced by some remarks on the vertical and horizontal distribution—a subject which, from the nature of the specimens procured, is of no small interest.

While it is our purpose to treat the shore and deep-sea fishes separately, it is manifestly inconvenient to relegate to distant parts of the text species which, though differing in vertical habitat, are so closely allied as to call for comparative description. We have, therefore, endeavoured to evade the difficulty by affixing to the name of each species the category to which it belongs, whether "deep-sea" or "littoral," and have further appended a list of the forms which come under these two headings. Purely Pelagic forms are unfortunately not represented in the Survey collections.

In determining the qualifications which relegates a species to one or other category we have followed Dr. Günther,† and shall therefore include amongst the

* The publication of this Paper has been unavoidably delayed.

† "Report on the Deep-Sea Fishes."—"Challenger," vol. xxii.

deap-sea fishes all which have been, or are now for the first time, recorded from depths exceeding one hundred fathoms. That this distinction is to a great extent one of convenience only (since it classes in the abysmal division many forms which have a mainly littoral habitat) has been pointed out by Dr. Günther himself, who has suggested the three-hundred-fathom line as a more natural demarcation. Seeing, however, that the great "Challenger" work is our classic in the literature of the subject, it appears advisable, in a small Paper like the present, to adhere to the limit therein adopted, and thus to avoid a possible source of confusion. We may also remark that since the Macruridæ, a family of typically abysmal structure, sometimes occur in water of less depth than one hundred fathoms, a lowering of the vertical line of demarcation would not be without its disadvantages.

It appears to us that we can greatly enhance the value of this Paper by mentioning in it all deep-sea forms which have been taken off the Irish coast. We only propose however to give descriptions of such as have come under our own observation. In other cases, we shall merely give a reference to the publications in which their occurrence is noted. We shall also refer to the capture, in deep water, in other localities, of species only known as littoral in Irish waters. There is, so far as we are aware, no such list in existence, and it can hardly fail to be convenient to future workers in the same field.

In the case of the purely littoral fishes there is not the same want, since Dr. Scharff's catalogue of the fishes in the collection of the Science and Art Museum gives a complete list (up to 1889, the date of publication), and we need only note the addition of any species which were obtained since then, either during the Survey or otherwise. It will be understood that species which find a place in the Catalogue, and which are not recorded as abysmal forms in this Paper, are confined, so far as we are aware, to littoral waters.

Since the days when William Andrews and A. G. More explored that district the fish fauna of our most western coast has suffered some neglect. The "Porcupine" made a few hauls of the dredge in the neighbourhood of the bank which now bears its name, and the results formed a few additions to the list of British fishes.* In 1885 Professor Haddon organised and carried out the first of a series of deep-sea dredging cruises, and since then, up to the commencement of the Survey, no year has elapsed without a record of some good work in this direction.

The valuable contributions to our knowledge of marine invertebrates thus afforded need not be specially referred to, and although the "Lord Bandon" and "Flying Falcon" expeditions yielded information of great interest, the ichthyological results of which have been published by Dr. Scharff,† it was not until

* Günther, Ann. Mag. Nat. Hist., 1874. † Proc. Royal Irish Acad., 1890, p. 456.

1889 that the investigation of the abysmal fish-fauna became the subject of chief inquiry. In that year Mr. Green, who had co-operated with Professor Haddon in his earlier cruises, and to whose enthusiasm and practical experience much of the success attending them was due, carried out a series of investigations in the "Flying Fox," which proved of peculiar interest. To certain improvements in the fishing gear, which Mr. Green's practical knowledge of trawling suggested to him, must be attributed, in great part, the unwonted proportion of fish in the hauls of that year. Dr. Günther's paper* for the first time enabled us to realize how vast a mass of unexplored material lay ready to our hands; and, in the same year, Mr. Bourne's observations, in H.M.S. "Research," Captain Aldrich, R.N., took up the work at the point where Mr. Green had left it, and yielded most valuable results.†

These had led us to expect much from continued work in the same field. To quote Günther's words:—"Not merely in the addition of a number of unknown forms to our list, but equally, and even more, in the certainty that many of the mysteries, which observations limited to the littoral fauna must for ever leave unexplained, will be cleared up by a study of the Pelagic and Bathybial conditions."

The Society's Survey offered peculiar advantages. Whilst its objects—of an economic nature—confined the fishing operations for the most part to the littoral waters, it was none the less incumbent that the deeper regions should also be to some extent explored. Our hopes have not proved without foundation. While extending the horizontal range of several species, by their addition to the British or Irish fauna, we are also able to extend the vertical range of some of them, and it will be seen that this extension may throw light upon the life-history of several forms.

The points in common between the fauna of the West of Ireland and of the Lusitanian region have for many years compelled the attention of naturalists, both in regard to terrestrial organisms and to marine invertebrates. If the similarity of the fish fauna has attracted less notice, it is probably because less attention has been devoted to it, and, perhaps, also because, so far as is known, it is very similar to that of the south-western coast of England. With regard to the latter, the great help which Raffaele's Mediterranean researches give to workers in the embryology of the Teleosteans of that region is, as Mr. Cunningham has observed, a sufficient proof of the close resemblance of the faunas.

That a connection should exist between the western Irish and Scandinavian fish-faunas appears, at first sight, less remarkable, since both belong to the North Atlantic. Accordingly it does not seem to have been the subject of special

* Ann. Mag. Nat. Hist., 1889, p. 415.

† Journ. Marine Biol. Assoc., N. S., vol. i., p. 306.

comment. However, if we can prove that our western coast is the meeting-place of the two faunas,* it may be of more interest.

The littoral waters having been fairly well explored, we hardly expected to be able to add much to our knowledge on this point, and our discovery of *Aphia pellucida* and *Crystallogobius Nilssonii*, though interesting as additions to the Irish list, only seems to show that these forms, common to Norwegian and Mediterranean waters, are, as might be expected, not absent from the intermediate localities. The latter, indeed, has since been found to be very abundant on the eastern and south-western coasts of England.

Unquestionably a more important addition to the Irish list is that of *Gobius Friesii*, a species only known hitherto from Scandinavian waters, and the capture of no less than four examples of *Arnoglossus Grohmanni* is not without interest, since it serves to prove that this Mediterranean fish, of which only two examples had previously been taken in British waters, is more generally distributed than was supposed. *Rhombus norvegicus*, a Scandinavian form which we were able to add to the Irish list, had already been recorded from a more southern point in English waters, and has since been found to be rather plentiful on the coast of Cornwall.

When we turn to the deep-sea fishes we get more interesting, or, at least, more novel results. So much yet remains to be done in the field of deep-sea exploration that we are not warranted in insisting too strongly upon the localization of species living at a depth where the climatic conditions of the surface are little, if at all, felt; nevertheless, making use of such knowledge as we possess, the mixture of northern and southern species in the composition of the bathybial fish-fauna of our western coast is very striking. Thus, from the south we have *Centrophorus squamosus*, *Pomatomus telescopium*, *Hoplostethus mediterraneus*, *Gadus argenteus*, *Macrurus æqualis*, *M. lævis*, and *Rhombus Boscii*, as it were in the same haul with the northern *Gadus Esmarkii*, *Haloporphyrus eques*, and *Macrurus rupestris*, not to speak of other forms more generally known.

Scorpæna dactyloptera and, perhaps, *Macrurus cœlorhynchus* are forms which have been found both in Norwegian and Lusitanian waters, while *Argentina sphyræna* seems to be fairly cosmopolitan. *Pristiurus melanostoma*, a common littoral form in the Mediterranean, proves to be with us, as in Norway, confined to deep water. The same applies to a great extent to *Phycis blennioides*, although we certainly took one example in quite shallow water, and the species is known to occur in the North Sea at depths far short of one hundred fathoms.

Günther † was the first to direct attention to the fact that certain forms (*e. g.* Gadus, sp.) which inhabit the littoral region in the northern latitudes are

* Professor Haddon has already called attention to the same fact in the case of certain groups of invertebrates.

† "Study of Fishes," Edin., 1880, p. 265.

also to be met with nearer the Equator, but only in the somewhat deeper regions in these more southern areas. The subsequent experience of ichthyologists has not only confirmed this, but has also, as we have seen, established the truth of an exactly converse phenomenon. Either condition renders it somewhat difficult to formulate the relationships of structure to vertical habitat in the case of fish which inhabit or cross the border-land dividing the deep-sea and littoral areas; but the coincidence of both phenomena throws great obstacles in the way of a satisfactory explanation of either.

The increase in pressure which accompanies increase in depth of water seems to have impressed Day with the necessity for some special structural provision in the case of physoklistous fishes, and he puts forward a conjecture that the larval physostomous condition may persist throughout life in such examples of a species, normally physoklistous and normally littoral, as are found inhabiting great depths.* As a matter of fact, such provision (which has, moreover, no existence) is quite uncalled for, since we know by analogy that the objection is far from formidable. Thus, to take a common instance, every fisherman knows how readily the air-bladder of the ling (*Molva vulgaris*) is distended by even such a slight diminution of pressure as is brought about by hauling the fish up from a depth of only thirty fathoms, or thereabouts. Now, the vertical range of the ling is about 0·2 to 150 fathoms; and while we learn from Collett that young examples are rarely met with on the Norwegian coast at less than one hundred fathoms, a young fish has been observed by one of us, at St. Andrews, contentedly swimming in a shallow tidal pool.

It follows, therefore, that however much a sudden alteration of outside pressure may affect a physoklistous fish, the latter is quite capable of adapting itself under natural conditions to a very considerable vertical range. Indeed, had the enormous vertical range of some of the deep-sea fishes been present to Day's mind, he probably would not have ventured upon such a fantastic suggestion.

M. Vaillant, in the introduction to his discription of the ichthyological results of the voyages of the "Talisman" and "Travailleur," draws attention to the resemblance which exists between the bathybial fish-fauna of the regions explored by those vessels and the fish-fauna of the Polar waters. His remark, no doubt, refers rather to a resemblance of structure in the fishes inhabiting these two areas than to any general identity of the species composing the two faunas. We may so expand this proposition as to imply that the same type of specialization is associated indifferently with either an Arctic or a bathybial habitat, an implication which will be found to be borne out by the facts of the case.†

* "Fish. Great Brit.," I., pl. lxxxviii.

† We refer to type of general confirmation, and not to such characters as the reduction of the eyes, or the development of luminous organs.

Now, if the occurrence of northern littoral forms in the deep-water of the southern region were the only instance of a change of vertical habitat in relation to latitude, it might readily be assumed that the temperature was the consideration which drove the northern forms into deeper water, since, as is well known, the abysmal regions are practically unaffected by the surface temperature. Hence we might conclude that such-and-such a species was intolerant of great heat, and varied its vertical habitat accordingly.

But, although there may be a measure of truth in this theory, the occurrence of southern littoral forms only in the deeper parts of more northern seas, prevents us from accepting it as an entirely satisfactory explanation, and suggests the idea that it may be an equability of temperature throughout the year which is the desideratum, rather than any particular degree of heat or cold.

There is, however, an interpretation which appears to us infinitely more probable than any that can be deduced from conditions of temperature alone, and that is, that the struggle for existence drives the feeblest forms to the least desirable localities. The principle can, of course, be only very broadly interpreted, since not all the northern forms are feeble, nor do all the deep-sea fishes show signs of being descended from ancestors which were feebler than those which maintained their position nearer the shore.

It is, indeed, not necessary to assume that the bathybial forms of the present day have descended from fish which differed to any appreciable extent from their more successful competitors, since we know that in an aquarium there will always be found, among a number of fish of one species, which are to all appearance equally capable of taking care of themselves, some which manage to get most of the food, and some which fail to obtain their share, and so fail to grow at the same rate as the others. The reason, no doubt, lies in some congenital defect (whether mental or physical) which is not apparent to our intelligence; and we may assume that, in order to maintain an existence at all, such individuals migrated into regions of less competition, and (the process of evolution conforming to the changed conditions of environment) begat a race of descendants which ultimately came to exhibit characters of a degenerate order, if judged by the requirements of littoral life.

We do not, of course, claim originality for this proposition, which will be recognised as practically a recapitulation of Moseley's theory of the evolution of the bathybial fish of the present day, but we suggest that the resemblance of the Arctic to the bathybial fish-fauna is explicable on the ground that it has been brought about by precisely the same cause, viz. a migration to a more barren region. The resemblance disappears when we come to characters which have a distinct relation to bathybial requirements, such as the reduction of the eyes and the development of luminous, and of the presumably tactile, organs.

Why such a form as *Phycis blennioides* or *Pristiurus melanostoma* should be able to compete on equal terms with the littoral fishes of the Lusitanian region, and should fail with those which inhabit our own shallow waters is not apparent; but we certainly think that competition, not temperature, has consigned them to the deeper regions of our own sea, there to propagate, it may be, a race of typically abysmal descendants.

It is obviously impossible to formulate a rule which shall be applicable to all species alike, since we find that the conditions of latitude (and of competition) which admit a comparatively bathybial species, to littoral waters, are actually those under which another species (able to maintain its littoral position wherever it is found) reaches its greatest size. Thus the Witch (*Rh. megastoma*) inhabits only the shallow waters of the Iceland coast instead of the surrounding depths, while, under similar conditions of life, the Plaice (*Pl. platessa*) attains its greatest known size.

Indeed, in considering these matters, it is evident that we must take into account, not one condition or series of conditions (whether physical, competitive, or otherwise), but every condition which can possibly affect the species; and for this purpose the necessary information is lacking, and may, perhaps, never be accumulated.

It is, therefore, with a full consciousness of the inadequacy of our knowledge and of the probable imperfection of our conclusions that we have ventured to make the above suggestions. We may recapitulate them thus: that though, no doubt, there is a degree (whether of cold or heat) beyond which fish of a given species cannot exist, the cause that governs a change of habitat in accordance with latitude is mainly one of competition, and not of temperature.

In concluding our introductory statement, a few words are necessary as to the arrangement and classification of the forms dealt with. In selecting species for illustration we have sought to figure such as have not already been depicted in works dealing with British or Irish zoology, since our treatment of the material is, in a sense, national, in accordance with the wishes of the Society's Council. It follows that several forms, of which good drawings already exist, either in works of general zoology, such as the "'Challenger' Memoir," or in foreign literature, are again figured here. We have also endeavoured, by the insertion of generic diagnosis, where required, to identify fish belonging to genera not already described in the literature of British ichthyology, and whenever we have found no reason for alteration, we have simply reproduced the diagnosis of previous authors, with due acknowledgment. It will be noticed that the classification we have employed differs from that adopted by one of us in the reports published in the "Scientific Proceedings" (vol. vii., N. S.. Pt. IV.). In these reports, which are more or less popular in character, it seemed advisable to deal

with the fishes in the order given by Day, in his "Fishes of Great Britain and Ireland," as the most reliable work on British ichthyology accessible to the general public. In the present case there is not the same need, and we have therefore adopted what seems to us the most natural classification, which is practically that of Dr. Günther.

We have considered it undesirable, in the case of most species, to incumber the descriptions with a complete list of references, and have therefore eliminated all that appear to be of only minor importance. It must also be understood that in no case do we hold ourselves responsible for the correctness of the synonomy given by the authors referred to. In the case of forms which are only treated in respect to their vertical or horizontal distribution we have referred only to such records as are concerned therewith.

ELASMOBRANCHII.

HOLOCEPHALA.

Genus **Chimæra**, Linnæus.

Chimæra monstrosa, Linnæus. The Rabbit Fish, or King of the Herrings. (Deep-sea.)

Chimæra monstrosa,	. . .	Günther, "Cat. Fish. Brit. Mus.," viii., p. 350; "Chall.," xxii., p. 12; "Ann. Mag. Nat. Hist.," 1889, p. 415.
,,	,, . . .	Day, "Fish. Great Brit.," ii., p. 286.
,,	,, . . .	Vaillant, "Exp. Sci. Trav. Talism. Poiss." p. 80.
,,	,, . . .	Holt, "Sci. Proc. Roy. Dub. Soc., vii., p. 121.

This fish is represented in the Survey collections by five examples, taken in July, 1890, off Achill Head, at 220, 175, and 144 fathoms. It was previously known as a British form from specimens taken by the "Knight Errant" and "Triton" between the Shetland and Farœ Islands, at a maximum depth of 516 fathoms, and from an egg-case taken by the "Flying Fox," at 315 fathoms, off the S. W. coast of Ireland. We have received a skull, entangled on a hook to the W. of the Farœ Islands, and the occurrence of two examples between 70 and 135 fathoms to the north of the Great Fisher Bank has been recorded by one of us ("Journ. M. B. Assoc.," N. S., iii., p. 120). Another example, now in the British Museum, has reached our hands. from comparatively shallow water on the south coast of Ireland. Four small specimens were taken by the French scientific expedition in the Bay of Biscay at depths of 433 to 670 fathoms. The

species is also known from the coast of Norway and from the Mediterranean, from the Cape of Good Hope and Japan, and has thus a very wide horizontal range. As to the vertical range, the greatest depth of which we have seen a record is 516 fathoms (Farœ Channel), while our Iceland specimen, trawled at a depth which certainly did not greatly exceed 40 fathoms, is, perhaps, the only one certainly known to have been caught in littoral waters, exclusive of specimens cast ashore by storms or found floating at the surface. The Rabbit-fish, however, doubtless occurs not unfrequently above the 100-fathom line, though the finding of its egg-case demonstrates that, as Dr. Günther has suggested, propagation takes place normally in deep water.

The species is sufficiently well known, to obviate the necessity of a description in this Paper, but our examples illustrate a condition to which attention has not hitherto been directed.

In a male measuring 12 inches from the snout to the origin of the second dorsal, that fin arises at a distance from the true base of the first dorsal* equal to the length of the said true base. The posterior rays of the first dorsal are bound by membrane to the dorsum, so that there is formed an apparent base which extends to the origin of the second dorsal, and when the first fin is depressed about one-third of its spine extends beyond the origin of the second.

In a male of 15 inches from snout to second dorsal the true bases of the two fins are separated by an interval one-fourth longer than that of the first; and in a female of 16¼ inches (measured in the same way) the interval is twice as long as the true base of the first fin.

These examples, therefore, show an interval between the apparent base of the first and the commencement of the second fin, but the two fins are connected by a fold of skin. This is usually hidden in a groove of the dorsum in spirit examples, and we are not aware that its existence has been previously noted.

In comparing our examples with a series, of various sizes, in the British Museum, it is apparent that the separation of the dorsal fins is a feature which becomes more marked with the growth of the fish, but not in a degree that can be exactly formulated.

Dr. Günther, in comparing *C. monstrosa* and *C. affinis*, Capello, includes the whole apparent base of the first dorsal in remarking ("Cat." viii. pp. 350–351) that the second dorsal in the Portuguese species is removed from the first by a space equal to the base of the latter. This is evident from the figure given by Capello ("Journ. Math. Phys. Nat. Lisb." iv. 1868), to whom Günther refers as the authority for his statement. A further statement that the pectorals in *C. monstrosa* attain to the posterior extremity of the pelvics must be modified in view of the

* The base of the spine is included in this measurement.

condition exhibited by the specimens before us, in which the pectoral extremities are considerably short of those of the pelvis.

Judging by the variation which we have shown to exist in the interspace between the dorsals, this character may not always avail to distinguish between *C. monstrosa* and *C. affinis*, but the great space existing between the pectoral and pelvic in *C. affinis*, causing the former to terminate much in advance of the latter, at once separates the Portuguese species from any other that has been described.

PLAGIOSTOMATA.

SELACHOIDEI. Sharks

Fam.—CARCHARIIDÆ.

Genus **Galeus**, Cuvier.

Galeus vulgaris, Fleming. The Tope. (Deep-sea.)

Galeus vulgaris, ... HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., p. 219.

Examples were trawled at 154 fathoms, off the Coast of Mayo, on the 20th April. The tope was also met with in abundance in shallow water, usually in company with *Acanthias vulgaris*, and sometimes with *Scyllium canicula*. Though we believe that all three species are commonly caught by line-fishermen on the Farœ "Banks" at depths exceeding 100 fathoms, we know of no record earlier than that referred to above, which definitely includes them among the deep-sea fishes.

Fam.—SCYLLIIDÆ.

Genus, **Scyllium** Cuvier.

Scyllium canicula, Cuvier. The Lesser-spotted Dogfish. (Deep-sea.)

Scyllium canicula, ... HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., p. 219.

At 154 fathoms off the coast of Mayo. Common in littoral waters.

Genus **Pristiurus**, Bonaparte.

Pristiurus melanostoma, Rafinesque. The Black-mouthed dogfish. (Deep-sea.)

Pristiurus melanostomus, . . DAY, "Fish. Gt. Brit.," ii., p. 314.
" " . . COLLETT, "Nyt. Mag. f. Naturvid.," xviii., p. 117.
" " . . GÜNTHER, "Ann. Mag. Nat. Hist.," S. 6, vol. iv., p. 415.
Pristiurus melanostoma, . . HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 121, 219.

A young specimen was trawled at 144 fathoms, 30 miles off Achill Head, on 4th July, 1890. Three mature examples were taken on the lines at 154 fathoms, 28 miles off Achill Head, on 20th April, 1891, and another at 250 fathoms, 45 miles off Black Rock, Co. Mayo, on 12th May, 1891. Considering the limited extent of our fishing operations below the 100-fathom line, it seems probable that the species is fairly abundant in the deep waters off the west coast. It was never encountered in shallow waters during the survey; and such accounts as exist of its capture at various parts of the coasts of the United Kingdom give no particulars of the depths. A single young specimen was taken by the "Flying Fox" at 150 fathoms (Günther), while on the Norwegian coast it has been recorded from 250 fathoms (Collett). Thus though the Black-mouthed dogfish has most probably been occasionally met with in comparatively shallow water in the British area, the balance of the evidence seems to show that it is on the whole a deep-sea fish in the Northern parts of the Atlantic, whereas it is well known as a common littoral form in the Mediterranean.

Fam.—**SPINACIDÆ.**

Genus **Acanthias**, Risso.

Acanthias vulgaris, Risso. The Picked Dogfish. (Deep-sea.)

Acanthias vulgaris, ... HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., p. 219.

At 154 fathoms, coast of Mayo. Common in littoral waters.

Genus **Centrophorus**, Müller and Henle.

"Two dorsal fins, each with a spine, which is sometimes hidden below the skin; no anal fin. Trunk elongate, without lateral folds. Mouth wide, but slightly arched; a long, deep, straight, oblique groove on each side of the mouth. Teeth of the lower jaw with the point more or less inclined backwards or outwards. Upper teeth erect, triangular, or narrow, lanceolate, with a single cusp. No membrana nictitans; spiracles wide, behind the eye. Gill openings narrow.' (Günther.)

Centrophorus squamosus, Gm., Linn. (Deep-sea.)

(Pl. XLIII., 1, 1*a*, 1*b*.)

Centrophore écallieux, . . .	BROUSSONET, "Mem. Acad. Sc.," 1780, p. 675.
Squalus squamosus, . . .	GMEL. LINN, vol. i., p. 1502.
Centroscymnus ? squamosus ?,	MÜLLER & HENLE, "Plagiostomen," p. 90. pl. xxxiv.
Centroscymnus squamosus, . .	BOCAGE & CAPELLO, "Peix. Plagiost."; "Proc. Zool. Soc. Lond.," 1864.
Macephilus dumerili, . . .	JOHNSON, "Proc. Zool. Soc. Lond.," 1867, p. 713
Centrophorus dumerilii, . .	GÜNTHER, "Cat. Fish. Brit. Mus.," vol. viii., p. 423.
Centrophorus squamosus, . .	GÜNTHER, "Cat. Fish. Brit. Mus.," vol. viii., p. 422.
,, ,, . .	VAILLANT, "Exp. Sci. 'Travail.' 'Talism.' Poiss.," Paris, 1888, p. 75.
,, ,, . .	HOLT, "Proc. Roy. Dub. Soc." vol. vii., p. 219.

Remarks on the Synonomy.—We have followed Vaillant, the latest writer on this species, in considering the forms described as *C. squamosus* and *C. Dumerilii* as varieties of one species, since certain examples amongst those collected by the "Talisman" and "Travailleur" are described as presenting a mixture of those characters in virtue of which the species were originally separated. The matter is treated at greater length below.

DIAGNOSIS OF SPECIES.—*Scales*, small and sessile on the snout and fins, larger, pedunculate, and leaf-like, with posterior denticulations on the sides of the body; longer than broad, with a stout median keel projecting in front and behind, when viewed superiorly: a lateral keel on each side, variable, may be strongly marked,

when the denticulations of the posterior border are numerous and small, and the extreme lateral margins show traces of a secondary pair of keels; or may be feeble, the posterior denticulations being few and large; or may exhibit a condition between those described.

Teeth in upper jaw with a single sharp cusp, either narrow, the length of cusp much greater than the base, or broader, the outline of the cusp forming nearly an equilateral triangle. In the lower jaw the cusp is either narrow and almost perpendicular, or broader, with a well-marked lateral deflection. A median tooth usually present; absent only in extreme varieties. *Colour* uniform, either brown, inclining towards mahogany colour, or very pale, from chalky-white to blackish-grey. White specimens become a dull brown after immersion in alcohol. Iris black. Pupil clear emerald-green.

Dr. Vaillant, in his remarks on the "Talisman" and "Travailleur" collections (*op. cit.*, p. 69), pointed out, for the first time, that those forms which had hitherto been described as *C. squamosus* and *C. Dumerilii* are in reality only varieties of one species, to which the older name, *C. squamosus*, must, of course, be applied, while *C. Dumerilii* must be treated in future as a synonym. The amalgation of the two forms is due to the occurrence, amongst the specimens which came under Vaillant's notice, of examples exhibiting intermediate characteristics. Vaillant has, unfortunately, not given any detailed information in regard to the particular features which influenced his decision; but the specimen examined by us gives in itself sufficient proof of the truth of his assertion, and we have accordingly constructed a diagnosis of the species which includes both forms.

There exists, unfortunately, some confusion as to the nomenclature of the two so-called varieties. *C. squamosus*, Gm. Linn., is founded on the *Centrophore écailleux* of Broussonet; but Vaillant, who has re-examined Broussonet's type specimen (a somewhat mutilated head), states that it is not the *C. squamosus* of later authors—notably Günther, in the "Catalogue of the Fishes in the British Museum," vol. viii., p. 422—but the *C. Dumerili* of Johnson.

The specimen examined by us bears in almost every particular the features of the variety, *i. e.* the *C. squamosus* of Günther and other late authors. In the vital particular of teeth, however, we find that, while exhibiting the broad cusps of the lower jaw strongly deflected outwards, in a manner quite in keeping with the other features of *C. squamosus*, Günther, a median tooth is present in both jaws. Median teeth are one of the most important distinguishing features of the type-species, the *Centrophore écailleux* of Broussonet and *C. Dumerili* of Johnson. We therefore second the amalgamation of the two forms which was proposed by Vaillant for reasons which probably are not less important than those noticed by that author.

The two varieties, taking the extreme development of the characters which

serve to distinguish them, present the following features, as most clearly described and illustrated (*op. cit.*, Pl. III.) by Vaillant:—

Type of Species.	Variety.
"*Espèce typique*" (Vaillant). *Centrophore écailleux*, Brouss. *C. Dumerili*, Johns. (*et auctorum*).	*C. squamosus*, Günther, Cat. (*et auctorum*).
Colour.—Brown, more or less mahogany.	*Colour*.—Blackish-grey.
Fins.—Height of first dorsal nearly half the length of its base; height of second dorsal a half, or less than half, the length of its base.	*Fins*.—Height of first dorsal less than one-third the length of its base; height of second dorsal more than half the length of its base.
Scales.—Lamella nearly as wide as long, lateral keels strongly marked, posterior denticles fine, numerous.	*Scales*.—Lamella considerably longer than wide, lateral keels feeble, posterior denticles large and few.
Teeth.—In the upper jaw with narrow cusps; in the lower jaw with nearly vertical cusps; a median tooth present.	*Teeth*.—In the upper jaw, with cusps forming almost an equilateral triangle; in the lower jaw, with cusps strongly deflected outwards; a median tooth present or absent.

It may be further stated that the spines of the dorsal fins are stouter and more curved in the type than in the variety.

We may be allowed to call attention to the well-known fact that the development of a Plagiostomous fish is accompanied by very considerable changes in its dermal armature, which, moreover, is frequently different in the sexes. It follows, therefore, that great caution is required in distinguishing such species as depend for their separation chiefly on the characters of the scales and teeth. Whether in the case of *C. squamosus* there is any marked difference in the dentition of the two sexes is a matter as to which we have no information. All Vaillant's specimens were males, as is also our own, and we have seen no description of a female (specially described as such). Hence we must admit that possibly the diagnosis we have compiled may be applicable only to males.

The pedunculate or sessile character of the scale has been made the basis of a subdivision of the genus *Centrophorus*, which has not received much support from subsequent authors. As Vaillant points out, even those species which possess pedunculate scales have also sessile scales on some parts of their body; and we would even go further, and suggest that the pedunculate character cannot even be applied as a specific test at all stages of development. In the absence of any knowledge of very young forms this is mere conjecture; but it appears to us very possible that no member of the genus exhibits pedunculated scales when very young.

Size.—The maximum size recorded is 142 cm. (4 feet 8 inches), Bocage and Capello.

Vernacular Names.—At Setubal, Arreghonda (B. & C.); Arregonhada (Vaillant).

DESCRIPTION OF SPECIMEN.—Only a single example was taken during the Survey; it is an adult male. A sketch of it is given in fig. 1, Pl. v.

Dimensions.

	CM.	INCHES.
Total length,	105	41½
Total length without caudal fin,	93	36½
Tip of snout to eye,	6	2⅜
,, ,, to angle of jaw,	12	4¾
,, ,, to base of pectoral,	24	9½
,, ,, to base of first dorsal spine,	36·5	14⅜
,, ,, to base of second dorsal spine,	75	30
,, ,, to commencement of first dorsal fin,	38	15
,, ,, to commencement of second dorsal fin,	76·5	30 9/16
,, ,, to anus (cloacal opening),	68·8	27⅛
Length of eye,	6	2⅜
Length of pectorial fin,	13	5⅛
Length of base of first dorsal fin (without spine),	10	3 14/16
,, ,, second ,, ,, ,,	6·5	2 9/16
Greatest height of first dorsal fin,	5·3	2⅛
,, ,, second ,,	5	2
Width of interorbital space,	4·9	1 14/16
Width of intraspiracular space,	7·5	3
Greatest height of body (from base of first dorsal spine),	16·5	6½

Proportions.—The eye is equal in length to the snout; its length is greater than the width of the interorbital space, and less than the distance between the spiracles. The length from the tip of the snout to the last gill slit is contained about 4½ times in the total length (without the caudal), and is somewhat greater than the greatest height of the body. The extreme length of first dorsal fin is equal to 2⅓ times the height; in the second dorsal fin the length is 1⅓ times the height. The base of the second dorsal is two-thirds of the base of the first dorsal, which is one-third of the interspace between the two fins (spines excluded in these measurements). The extremity of the outer lobes of the pelvics are about opposite the base of the second dorsal spine, the extremities of the claspers opposite the middle of the base of the second dorsal fin.

Shape.—When newly caught the specimen presented a plump, well-rounded contour, with no marked trihedral aspect in section, such as characterises many ground sharks, though the ventral surface was slightly flattened. It has been

sought, so far as possible, to restore this condition in the sketch, since the action of alcohol had greatly shrunk the tissues by the time a detailed examination could be made.

Fins.—The extremities of the dorsal fins extend for a considerable distance beyond their respective bases, so that in the case of the second dorsal the extremity almost reaches the commencement of the dorsal lobe of the caudal, and overhangs a considerable part of the ventral lobe. Both dorsals are much alike in shape, the dorsal margin being convex in the anterior, and concave in the posterior region, each terminating in a narrow-pointed process parallel to the dorsum.

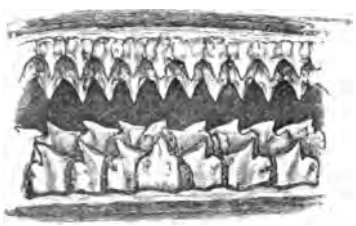
The dorsal lobe of the caudal, commences immediately behind the free end of the sound dorsal. It rises gradually in height, and terminates in an expanded process, extending well beyond the posterior extremity of the vertebral column. We presume that this process is rounded (as represented in the sketch) under natural conditions; but in our specimen a portion is missing, so that the sketch must be regarded as, in this respect, a restoration. The ventral lobe commences opposite a point about midway between the end of the base of the second dorsal and the free extremity of that fin. It is roughly triangular in shape, but its posterior face is very irregular in outline (*vide* Pl. XLIII., fig. 1), and its base fails to reach the end of the vertebral column. The dorsal and ventral lobes are therefore quite unconnected in our specimen, though how far the latter conforms in this respect to the normal condition we are unable to say.

Scales.—These impart to the skin rather a velvety appearance when viewed from a certain distance. This is seen on close inspection to be due to the fact that the lamellæ, though overlapping each other, are at the same time somewhat outwardly directed. The scales on the anterior part of the head and on the fins are small and sessile. A group of scales from the side of the body is shown in fig. 1*b*, and a single scale is seen, as it appears in lateral view, in fig. 1*a*, which sufficiently illustrates the pedunculate character in that region of the body. On comparing fig. 1 *b* with Vaillant's drawings (*op. cit.* Pl. III., figs. 2 and 3), it will be seen that the scales of our specimen appear to differ considerably in shape from either of those represented by the French observer; but this is due entirely to a slight difference in the point of view from which the figure was made. It will further appear that in the greater elongation of the lamella the agreement is rather with the variety (*C. squamosus*, Günth. et auct. plur.) rather than with the typical form. In the strength of the lateral keels, however, our examples are somewhat intermediate. So also with regard to the posterior denticles; for out of the group of four selected at haphazard by the artist, two show the few and bold denticles of the variety, whilst the other two, especially the most anterior one of the group, exhibit numerous and fine denticles. In scales, therefore, it appears that our Irish example is to some extent intermediate, but inclines, on the whole, chiefly to the condition of the variety.

Eye.—The emerald green pupil is very large, and in the fresh condition is the more conspicuous, since a great part of the black iris is hidden by a folding-in of the skin of the head.

Labial folds extend from the angles of the jaw for about one-third of the length of each side of the upper jaw, and are consequently somewhat widely separate from each other in the middle line.

Teeth in three vertical rows in upper, and two rows in under jaw. In the upper jaw the middle, in the under jaw the inner row appear to be chiefly functional. In the upper jaw there are 35 teeth in each transverse row, *i. e.* 17 on each side of a median tooth. In the under jaw there are 29 teeth in each row, 14 on each side of a median tooth. The annexed woodcut represents the central region of the mouth, seen from the ventral aspect. In this the median teeth are distinctly visible.



Central region of jaws of *Centrophorus squamosus*.

The presence of the median teeth in this specimen is of some interest, since the dentition, in other respects, is completely characteristic of the variety, as referred to above.

Anatomy.—Of the visceral anatomy it may be remarked that it does not differ in any essential degree from the familiar littoral Selachian type. Moreover, Günther's description ("Chall.," vol. xxii., p. 6) of the viscera of the Japanese *C. squamulosus* reveals an arrangement so much like the condition seen in our own example that one description might do for both, except for the fact that the specimen described by Günther was a ripe female, 27 inches long, whereas that now under consideration is a mature, but unripe male.

The testes are of equal size, situated on a level with the first dorsal fin, white in colour, and typically reniform in arrangement.

Colour.—When first brought to the surface our specimen was of a uniform chalky-whiteness, but shortly became darker, assuming a pale-leaden hue. The difference between such and the blackish-grey colour stated by Vaillant to characterize the variety seems unimportant, as it is evidently more the result of a greater or lesser degree of expansion of similar chromatophores than of any other distinction. In colouration, therefore, we may say that our specimen conforms to the variety rather than to the type. An attempt, in fig. 1, to reproduce on so small a scale something of the velvety appearance of the skin has resulted in making the fish look somewhat darker than it was in the living condition. The action of alcohol has now caused a dull-brown colouration of the skin, whilst, of course, the vivid green of the crystalline lens has entirely disappeared.

LOCALITY AND DISTRIBUTION.—Only one specimen was taken on a long line on May 24th, 1891, at a depth of 250 fathoms, 45 miles off Blackrock, Co. Mayo.

The species was not previously known as an inhabitant of the British area, nor is much information as to its geographical distribution available. It has long been known, however, as an inhabitant of the deep-water off the coast of Portugal, where, with other of its congeners, it forms the object of a regular fishery. This was first brought to public notice in this country by Dr. Perceval Wright, who had occasion to visit Setubal when endeavouring to verify the presence of Hyalonema in European waters. He has given (Ann. and Mag. Nat. Hist., 1868, vol. ii., p. 426) an interesting account of his experiences, but the only species identified on that occasion was *C. cælolepis*. This led to an expression of opinion by Dr. Günther ("Chall.," vol. xxii., p. 5), that all the European members of the genus were inhabitants of deep water, and the results of the expedition of the "Travailleur" and "Talisman" have since shown that this is the case.

Dr. Vaillant himself took part in a fishing cruise in one of the boats engaged in the industry, and his account is of such interest that we make no apology for paraphrasing it at considerable length.

He remarks that the shark fishery at Setubal, of which *C. squamosus* is the commonest product, has been in existence from time immemorial, and constitutes a regular industry, though the number of boats engaged, viz. three at Setubul and about as many at Cezimba, is not considerable. The boats are about sixteen or nineteen feet long, broad, and strongly built, but are at the same time "balanced so as to yield to the slightest impulse of the water,"* and therefore able to keep the sea in foul weather; this is the more advisable since the distance of the fishing-grounds often necessitates a trip of several days' duration, with a possible difficulty of making the harbour on return.

The particular boat selected by Dr. Vaillant for observation was manned by nine men and a boy.

The apparatus employed consists of lines, mounted at equal distances with cod-hooks on snoods about five feet in length, each line being about 97 feet long. From 20 to 40 of these lines are joined end-to-end, in the usual manner, so that from 400 to 800 hooks are employed at the same time.

The lines are shot from the bow, the boat meanwhile being rowed with a couple of oars—longer than those in ordinary use—in order to prevent fouling. The chief peculiarity of the operation seems to be that no buoys are used. The end of the line first shot is weighted with a couple of stones, whilst the last line is made fast to a cord about 700 fathoms long (termed by Vaillant a "maitresse corde"), one end of which is kept in the boat. From our own experience on board the "Harlequin" we can understand that this is a wise precaution, since, on the occasion when our Centrophorus was caught, although we were using

* This description seems to suggest something of the build of a whale-boat, or Greencastle "yawl," with a good rake fore-and-aft.

buoy-lines of what we considered ample length, one of the buoys disappeared soon after it was shot, and we were only just in time to catch the other, and had to increase its buoyancy by the addition of an empty ten-gallon spirit-carboy in order to keep it at the surface.

The operation of shooting takes about an hour and a-half, and there is then an interval of about an hour and three-quarters before hauling. This last is the most difficult part of the whole business, as the means employed by the Setubal fishermen are decidedly primitive. A kind of derrick, consisting of a plank, with a pulley at the end of it, is made fast to the mast and the false stem; the "maitresse corde" is placed on this engine, and the crew, seating themselves in pairs on each thwart, haul it in hand-over-hand, whilst the skipper coils it up in the stern. It is about two hours before the first line makes its appearance, when it is immediately passed to the starboard quarter. Here it is hauled by three or four of the crew, whilst the skipper stands by with the gaff, and another man takes the hooks out of the fish, and stows away the lines ("sans grand ordre") as fast as they come in.

The whole operation (shot and haul) witnessed by Dr. Vaillant took five hours and a-half, the sea meanwhile being remarkably calm. The catch was twenty-one sharks and eight specimens of *Mora mediterranea*.

Vaillant remarks that the presence of sand made it evident that a greater part of the line had been on the bottom, and that, moreover, if the fish inhabited higher zones, experience would long since have taught the fishermen the folly of using so costly and cumbersome an engine as the "espinheis"* for their capture. He also notes that there is on the coast a large population entirely engaged in fishing, and the fact that these sharks are never caught except in the manner described is a sufficient proof that they are exclusively confined to deep water.

That they have a considerable horizontal range was evident from the capture of a few small individuals belonging to some of the species fished for at Setubal, at points widely distant from each other, and he is no doubt right in attributing their scarcity in the collection of the expedition, as due not so much to their rarity as to an agility which ensures them a certain immunity from the trawl. The trawling operations of the "Harlequin" in the vicinity of the spot where our specimen was obtained do not throw much light on this subject, as in one haul the net was capsized, and in the other nothing but the beam and irons came to the surface.

Inquiries were made by Vaillant as to the profits arising from the Setubal shark fishery, and it would appear that these are very slight. The chief commercial product is the skin, obtained mostly from *C. granulosus*, which is suitable for manufacture into a kind of "galuchat" (equivalent, we suppose, to the English trade

* A name applied by the Setubal fishermen to the apperatus described on account of the resemblance borne by the line and snoods to the "espinheis," or backbone of the fish.

term, "shark-skin"), this is of some little value. The skins of other kinds, however, including *C. squamosus*, are only fit for polishing wood, for which purpose the skin is dried and cut into long narrow strips. One such skin, the species being *Scymnis lichia*, was purchased by Dr. Vaillant for a franc and a-half, or thereabouts.

The liver yields an oil used by the country folk in their lamps, and particularly esteemed for the lubrication of wooden machinery. Finally the body of the fish is dry-salted and used for food just as our most familiar member of the family, *Acanthias vulgaris*, is used on the Cornish coast.

It is hardly to be wondered that Vaillant doubts how far such products would indemnify the cost of the gear and fittings necessary for such a fishery, and we have no reason to suppose that the inhabitants of the Mayo coast are ever likely to put the matter to a test; but there is no doubt, as Vaillant remarks, that similar gear might with advantage be used for scientific purposes, with a view to the discovery of forms not likely to be captured in trawls or dredges.

Batoidei. Rays.

Genus **Raia**, Cuvier.

Remarks on the Diagnosis of Species belonging to the Genus Raia.

The variation which is found amongst the species of this genus has proved a source of considerable perplexity and error to many observers.

The difficulty of identifying certain species is very great, and arises not only on account of the variation, but also because a custom has become established amongst writers to include in their diagnoses certain features which alter, to an extraordinary extent, according to age or sex. The relative convexity of the anterior margin of the disk, the arrangement of the dorsal and caudal spines, and the colouration and markings of the back may be taken as examples of the varying features referred to. The number of rows of teeth are generally looked upon as of paramount importance in the identification of species, but even here we find that considerable modification exists according to the age of the specimens examined.

It is therefore not surprising that in the descriptions of species from a limited number of examples at command, statements should have been made which in reality are applicable only to one sex at a certain stage in its existence, instead of applicable to the species as a whole.

When comparing mature examples of any species, a marked difference may at once be detected between the males and the females. The presence of claspers, and alar spines in the males alone, have always been recognised by writers, but

with a view of drawing attention to certain less conspicuous, but equally important differences occurring not only between males and females but between old and young specimens of the same species, the following observations have been introduced :—

(*a*) *The Relative Convexity of the Anterior Margin of the Disk.*—This feature is generally referred to as of specific value, without much reference as to the maturity or sex of the examples described. Day,* for instance, in dealing with *R. batis*, says:—"The anterior edge of the disk undulated and deeply emarginate below a line drawn from the end of the snout to the angle of the pectoral fins." A similar statement is made with regard to *R. macrorhynchus*, *R. alba*, *R. œyhrynchus*, *R. fullonica*, &c., and in none of these cases are we told the size or sex of the species to which the statements are applicable. In the case of *R. alba* we are indeed told that "In *young specimens* the disk is not so undulating along its border as in adults;" but again, we are left in ignorance as to the sex of the young specimens. Moreover, his description of the adult *R. alba* has in all probability been drawn up from a male example, which, following the course to be observed in all Raïdae, has a more deeply concave margin than the adult female. Even yet we may not conclude that his young specimen was a female, because young specimens of both sexes show less concavity in their anterior margins than adults.

(*b*) *The arrangement of the Dorsal and Caudal Spines.*—The dorsal and caudal spines, or dermoid denticles, are invariably arranged in rows, and may be spoken of as "linear spines." They form, in their arrangement, a conspicuous feature in the appearance of different species of the genus Raia.

Spines are also found conspicuously on the snout, and round the orbits. In certain species (*R. clavata*, *R radiata*) spines are scattered over the dorsum of the disk, but in the majority of cases the denticles found in this situation are insignificant, and they are never arranged in any definite order. We find it convenient to term these lesser denticles "spinules." They are stronger and more conspicuous in the female than in the male, except in the case of *R. radiata*, where the spines of large size are freely distributed over the dorsum, and where it may be said that no difference, in spinulation, exists between the sexes.

Spinules are present on the tail also, scattered between the linear spines, or formed into a sub-marginal border. The latter condition is seen in *R. circularis*, adult *R. alba*, *R. radiata*, and *R. microcellata*. In the description which follows as to the caudal spines these spinules are not considered.

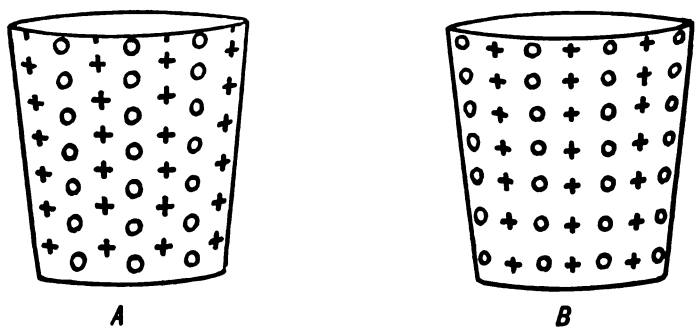
One other point must be noticed before treating the arrangement of the spines. Apart altogether from the alar spines already referred to as prominent only in mature male, it is interesting to notice that as sexual maturity is reached, *i.e.* as

* Day, "British Fishes," vol. ii., p. 336.

the claspers are elongating, and the alar spines (which are possibly erectile) are becoming conspicuous, the spinules along the anterior margin of the disk begin to develop rapidly. When the claspers are fully elongated, these spinules, much stouter than their fellows, form a band extending from the snout, to each angle of the pectoral fins.

The linear spines, when studied with reference to the gradual growth and development of any one species are found to be subject to regular changes. So much is this the case, that in diagnosing a species, writers have constantly been compelled to make their statements capable of considerable elasticity of interpretation.

R. maculata must be described as possessing a central row of spines along the back and tail, with one row or two rows on either side. In some cases the central row is less prominent than the side row or rows; in other cases the side rows are only represented by a few isolated, but large spines.



DIAG. 1.—*A* represents a section of the tail of a very young specimen, two and a-half inches across, and *B* a section from the tail of a specimen eight inches across. It will be noticed that in *B* the position of the rows of signs has been reversed, the central row being in *A* o and in *B* +.

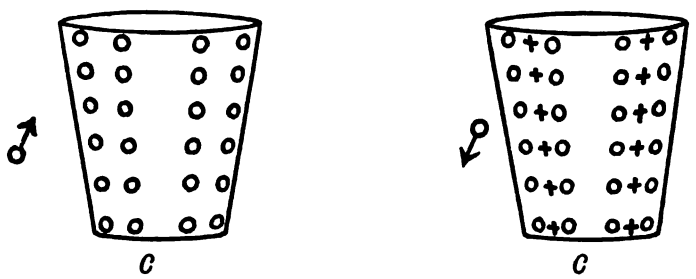
In *R. circularis*, at all stages, the tail is found to be possessed of many rows of spines; yet if a progressive series of examples be examined, a very instructive system of alternation is discovered.

In very small specimens of about $2\frac{1}{2}$ inches across the wings, the whole surface of the disk is more or less spinous, so as almost to resemble the condition seen in *R. radiata*—a ray which does not occur in Irish waters, so far as present records show us. The tail has a row of strong and prominent spines down the middle line, but on the disk the difference between spines and spinules is not yet great. On either side of this median row there is, at the root of the tail, a row of insignificant spines. These cease on a level with the posterior margin of the pelvic fin. On the outer side of each of these again comes a row of strong well-marked spines, which run from the sides of the triangular patch in the centre of the back to the end of the tail. Again, outside each of these rows there is a row of feeble spines, which, about half-way along the tail, assume the extreme lateral

position. There is therefore a regular alteration of rows of strong and feeble spines.

If now we observe the condition of these rows as the size of the fish increases, we notice that gradually, the spines which were large become insignificant, and *vice versa*. This change may, perhaps, be more readily understood by a comparison of diagrams *A* and *B*, where in each case the large spines are marked o, and the small spines +.

By a continuation of the same process the arrangement of the spines still alters. The small spines (+) of *B* become more and more reduced in size, and the central row gradually disappears. The ray is now about 12 inches in transverse measurement, according to our Irish specimens. The other small spines also become reduced, and when a condition of sexual maturity is reached we find that, in accordance with what has already been said as to the female being the more spinous sex, the small spines of the male disappear rather more rapidly than those of the female. In this manner a sexual difference becomes established in the adults, which may be illustrated in the following diagram:—



DIAG. 2.—Sections of tails of male (♂) and female (♀) *R. circularis* in adult condition.

The central row of spines is absent in both cases, and in the male all small spines have disappeared. In the female the row of small spines is still indicated. This row, however, does not extend in old specimens more than halfway along the tail.

Owing to the rate of growth being subject to considerable variation in different localities, it may very readily happen that the size (12 inches) given above for the disappearance of the central row of spines is too small, that in other localities, as the North Sea, the rays may be larger before this row disappears. The size, as stated, however, seems to represent a fair average in regard to Irish specimens. At the same time there is, in the large collection of rays and skates under review, a specimen of 12 inches—a female, which has still a distinct central row. The specimen has no alar ocellus, or circular spot on the wings, and will be referred to again.

Another species which shows, to a marked extent, the variation which exists amongst the linear spines, is *R. microcellata*. The female shows a condition

what similar to that seen in a young male, *R. circularis;* but if adults of both sexes be examined, a much greater contrast is found than exists in adult *R. circularis* as seen in fig. *C.* Taking a transverse section of the tail in both sexes, we present figs. *D* and *E.*

(*c*). *Coloration, and markings of the skin.*—It is a matter of common knowledge that colour variation, so frequently met with in fishes as a whole, is, at least, as frequent amongst the Raiidæ as in any other group. Nevertheless we invariably find a more or less precise statement of the pigmentation included in diagnoses of the species of this family. To eliminate such altogether is by no means desirable, but it is certainly necessary to allow great latitude of interpretation to existing descriptions.

The names *R. alba* and *R. maculata* indicate that both general colour and particular markings have been considered characteristic features of certain species; and in the case of *R. alba* we know that the dead whiteness of the ventral surface, which is certainly characteristic of the adult, has been found to be constantly

D *E*

Diag. 3.—*D* represents the condition found in adult females—one row of median spines, with two rows on each side. *E* is produced from nine examples of adult males, seven of which possessed the median row of spines alone, the other two specimens having, in addition, a few isolated spines on one side. The latter are indicated by the dotted spines.

diversified by bands of brown in the young. In *R. maculata*, again, we have observed a specimen in which the spots were wholly absent. The alar ocellus, which is so conspicuous in the Cuckoo Ray, is represented to a greater or less extent in the young stages of nearly all species of Raia which have come under our notice; and since it may be either very conspicuous or hardly discernible in the adult condition of a single species (*e.g. R. maculata*), it is evidently a character which should not be very strongly insisted on in specific diagnosis.

The whiteness of the ventral surface which characterizes the living condition of a great many rays is subject to considerable *post-mortem* changes, since it may become grey, or even brownish, when the fish has been dead for some time. *Post-mortem* changes are also noticeable in the general texture of the skin, owing at least in great measure to the drying influence of the atmosphere. Thus, a fish which, when fresh, appears perfectly smooth both to sight and touch, may be found, when stale, to be covered with minute asperities, imparting to the skin a distinctly granular appearance; and it seems very probable that a want of

appreciation of this circumstance has given rise to some of the existing confusion in the arrangement of the genus.

(*d.*) *The Teeth.*—That the shape of the teeth varies according to the sex of the individual in several members of the genus is a fact to which reference has ferquently been made, yet it has been too often left to the reader to discover for himself that this statement is often only applicable to adults. A young male, in fact, possesses teeth which usually differ in no important respect from those of a female, and it is only with the assumption of sexual maturity, *pari passu*, with the elongation of the claspers, that the teeth begin to show the elongated and pointed characters which are so conspicuous in the adult males of some species. Even in the several long-nosed species, which have the teeth pointed in both sexes, the points are slightly the longer in adult males. It seems therefore by no means improbable that these structures subserve some definite function in connection with sexual activity.

The number of rows in which the teeth are arranged is a character usually made use of in specific diagnosis; but it is one which possesses absolutely no value unless the size of the specimen is also stated, since the number varies with the age or size of the individual. As far as we are aware, such information is nowhere forthcoming. The result is therefore rather confusing. The difference in the number of rows at different stages may be illustrated by the statement that whereas a full-grown Homelyn (*R. maculata*) has over 50 rows, an example of the same species only 4 inches across the disk has less than 30 rows. Again, it is not invariably stated which jaw is referred to in the enumeration, but this is not of great importance since the number does not differ very greatly. However there are usually a few more rows in the lower than in the upper jaw.

Raia batis, Linnæus. The Grey Skate. (Deep-sea.)

Raia batis, . . . STROM, "Norsk. Vid. Selsk. Skrift.," 1881, p. 80; 1884, p. 46.
" " . . . COLLETT, "Nyt. Mag. f. Naturvid.," xviii., p. 119.
" " . . . HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 121, 219.

A small example was trawled on the 4th July, 1890, at 220 fathoms off Achill Head. Two, measuring 28 inches in length, were taken on 10th July, 1890, at 500 fathoms in the same neighbourhood, as was also a fine specimen of 54 inches, on 20th April, 1891, in 154 fathoms. None of these specimens were preserved, but they were carefully examined by one of us at the time of capture, and belonged, without doubt, to the species indicated. It is noteworthy that *R. circularis* is the only ray which has been found at a depth exceeding 500 fathoms. The grey skate has been taken on the Norwegian coast at a depth of 150 fathoms, and,

though the fact has not been definitely recorded, certainly occurs on the Faroe "banks" at depths exceeding 100 fathoms. As it is common in shallow water, it appears to have a vertical range practically coterminous with that of the Batoidei as a whole.

Raia oxyrhynchus (Linn.). The Long-nosed Skate. (Deep-sea.)

Raia oxyrhynchus, ...	Linnæus, "Syst. Nat.," i., p. 395.
,, ,, ...	Günther, "Cat.," viii., p. 469.
,, ,, ...	Day, "Fish Great Brit.," ii., p. 341.
Raia chagrinea, ...	Yarrell, "Brit. Fish" (ed. 1), ii., p. 414.
Raia vomer, ...	Günther, "Cat.," viii., p. 468.
,, ,, ...	Collett, "Forh Videns," 1879, p. 106.
,, ,, ...	Lilljeborg, "Sverig. o. Norg. Fish.," iii., p. 598.
,, ,, ...	Yarrell, "Brit. Fish" (ed. 3), ii., p. 548.
Raia rostrata, ...	Risso, "Ich. Nice.," p. 7.
Raia salviana, ...	Müller & Henle, p. 143.
Raia mucronota, ...	Yarrell, "Brit. Fish," (ed. 2), ii., p. 550.
,, ,, ...	Couch, "Cornish Fauna," p. 25.

Diagnosis of Species.—The width of the disk about one-tenth greater than its length; the anterior margin deeply concave. Outer angle of pectoral fin somewhat pointed. Snout much elongated and pointed, contained about three times in the width of the disk. Eyes elongated and flattened; in young examples about equal to width of inter-orbital space, which, in adults, equals the combined length of the eye and spiracle. Supraorbital ridge inconspicuous. Spiracles small, measuring transversly half the length of the eye. Distance from tip of snout to lateral angle of mouth equal to distance from same point to posterior margin of eye. Teeth pointed in both sexes, with a central keel, which is inconspicuous in young examples.

No large spines on disk. Tail with a row along each lateral edge,* and a median row, which is incomplete or absent in large examples. Both upper and under surfaces of the disk and tail covered with small spinules, but in young specimens the greater part of the upper surface is smooth.

Colours grey or greyish brown superiorly, frequently with a few whitish and dark-brown spots or streaks. The under surface a dark grey.

The long-nosed skate appears to occur with the greatest frequency off the coast of France and in the Mediterranean. It has been taken as far south as Madeira.

* These rows are probably absent in very young specimens, a central row being conspicuous.

We are able to record it, for the first time, from the coast of Iceland and from Rockall, whence it seems to be one of the commonest rays. It occurs occasionally during the spring and summer months at Plymouth and along the coast of Cornwall, but appears to frequent deeper water than the other skates usually landed on our coasts, and probably on this account is the more seldom seen. It has been recorded from the coast of Yorkshire, and from Norway, but is certainly rare in the North Sea. It seems to be generally distributed along the west coast of Ireland, but previous to the survey there existed no record of the capture in Irish waters of any fish which could with certainty be identified with this species.

The examples recorded by Thompson,* and more recently by Mr. Paterson,† if correctly identified with *R. oxyrhynchus* (Montagu) were in reality *R. alba* (Lacip), and Mr. Paterson's record of *R. mucronata*, a synonym of the species now under consideration, is admittedly doubtful.

The species is most easily recognised by reason of the feature to which its ordinary name applies, the long nose and deeply concave anterior margins of the disk.

During the Survey, a large specimen, measuring 50 inches in length, a female, was captured 30 miles off the coast of county Mayo. The trawl was let down on the rapidly deepening slopes of the continental plateau in 500 fathoms and hauled up in 375 fathoms. Other specimens, all immature, were taken in 25, 31–38, and 74–80 fathoms. The 50″ specimen measures 34 inches across the wings, which is also the measurement from the tip of the snout to the posterior extremity of the pelvic fin. Both sides of the disk and tail are covered with spinules, which point in a backward direction. These spinules are least prominent in the centre of the dorsum and most conspicuous on the under surface of the snout and head. The interorbital space is flat, and, like the median dorsal region generally, has a worn appearance. Round the inner side of the orbits, however, and especially in front of these organs, the spinules are again conspicuous. There is no trace of any spine on the disk. The spinules continue, without interruption, along the surface of the somewhat flattened tail. About an inch and a-half behind the posterior margin of the pelvic fins, on both sides of the tail, a row of conical spines make their appearance, and continue backwards, along the extreme lateral margin, to the level of the second dorsal fin. In the medium line of the tail are the degenerate remains of two spines. Both are now mere flattened bases, partially buried in the skin, and might be readily overlooked.

Another large female, taken off Gregory Sound on the 8th April, 1891, belonged to the same species. It measured 53 inches in total length, the width and

* "Nat. Hist. Ireland," vol. iv. p. 259.

† "Birds, Fishes, and Cetacea of Belfast Lough." Lond., 1881, p. 228.

length of the disk being, respectively, 36 and 31½ inches. The snout was 12 inches long, or exactly one third of the width of the disk. The weight was 32 lbs. The colour different from that of the last specimen, only in the presence of some irregular roundish lighter blotches on the upper surface, a difference of small importance under any circumstances, and of none at all when, as in the present instance, the variegated example came from only 38 fathoms, and the uniform example from some depth between 500 and 375 fathoms. There is no important difference in proportions between the two, but the spinulation differs in the entire absence of median caudal spines from the larger specimen. The lateral row is also wanting behind the level of the centre of the first dorsal.

Seeing that in the 50-inch specimen the median spines had almost disappeared, it is not surprising to find no trace of them in a fish 3 inches longer; yet the distinction between *R. oxyrhynchus*, and *R. vomer* seems to be based on the respective presence and absence of these spines. The two species were amalgamated by Day, but Lilljeborg, a more recent author, admits *R. oxyrhynchus* to the synonomy of *R. vomer*, only with the prefix of a note of interrogation. We venture to think that the observations recorded above most fully confirm the correctness of Day's opinion, and since, as we have noted in our introductory statement on the *Raiidae*, the adult male is almost invariably less spinous than the female, we think it likely that males may lose the median spines earlier than is the case with females. Unfortunately no notes were made on the spinulation of the males, nor were any preserved, but a large male was examined and measured by one of us on the same date as the female of 53 inches, and, in the absence of any note to the contrary, we are, perhaps, justified in inferring that it did not differ from the female in a character so important as that of the median spines. The total length of this example was 48 inches, the length and width of the disk 29 and 33¼ inches, and the length of the snout 10½ inches. It weighed 25 lbs.

The largest example taken during the survey was 63 inches long, but no record was made of the width of the disk or other measurements.

A rather interesting condition of spinulation is exhibited by a young female, measuring 22½ inches across the disk, which, though derived from the North Sea, is useful for comparison with the Irish specimens, since no others from Irish waters are available. The median caudal row is fairly complete, eight spines remaining, while scars mark the sites of two others. The spines, however, are much worn, nothing but the base and a slight apical prominence remaining. The lateral rows are only represented by one spine on one side, and two on the other, all posterior to the commencement of the first dorsal fin. They are evidently of recent growth, since they are quite perfect and sharp, and, no doubt, represent the first appearance of the more or less continuous row, which manifests itself in

larger examples.* Thus it would appear that the long-nosed skate resembles its common ally in the spinulation formula, since in *R. batis* only a central row is present in very young examples. The absence of median spines is a frequent feature in old common skates, but we are not aware that any observer has considered it of specific value, when dealing with that form. The apparent anomaly that in such small species (*e.g. R. maculata*) as typically exhibit a tri-linear arrangement of the caudal spines, it is the lateral and not the median spines that are most often missing in old examples, is explained by the difference in the history of the individual spines. In the small species the lateral spines, which may, or may not, be present in the adult, are older than, or as old as, the median spines, since they replace smaller spines, occupying the same position in very young examples, at a period of the life history which presumably corresponds to that which we have been dealing with in the case of the young long-nosed skate. At about the same period the median spines of the Homelyn begin to be replaced by the intercalation of a new series; but in the large skates no such new series is developed, and whatever median spines may be present in old examples are only the remnants of the original series. It is easy to understand that the renewal of the dermal armature of the young is a feature that would naturally be lost in the evolution of a species which attains such a size as either *R. batis*, or *R. oxyrhynchus*, the adults of which can have few enemies against which a prickly tail would be an efficient defence.

We have examined a mature male from Ireland; but can say nothing as to the spinulation of the tail, as that organ had, as usual, been cut off by the fishermen for convenience of packing, before the specimen reached our hands.

The dimensions are as follows:—

	Inches.
Width of the disk,	35
Length of the snout,	11½
Length of the eye,	1½
Combined length of eye and spiracle,	2¾
Distance between the supra-orbital ridges,	2½
Distance from tip of snout to centre of mouth,	12
Distance from tip of snout to coracoid,	19
Distance from tip of snout to anus,	29½
Distance between the inner margins of nostrils,	4½
Distance between the inner margins of either nostril and tip of snout,	10½
Length of the disk,	30½

The claspers are fully elongated; the *vasa deferentia* swollen; but the testes and the alimentary viscera are wanting.

* It will be remembered that the most posterior of the lateral spines were wanting in the largest examples, probably because these spines are the first to develop, and consequently the first to decay.

The upper surface of the disk is smooth, or very nearly so, over the cheek muscles, the gill-chambers, and the fleshy parts of the pectoral fins, as outlined laterally from the posterior alar sexual species forwards to the anterior alar patch, and backwards to the insertion of the pelvis. The lateral parts of the abdomen and the pelvic fins are also smooth. Elsewhere the upper surface is beset with asperities, minute over the vertebral abdominal region, and largest and most closely set on the anterior-third of the snout, and along the anterior margins of the pectorals. No large spines are present, exclusive of the sexual alar spines.

The under surface is everywhere beset with asperities, except on the claspers. The rest of the pelvic, and the posterior flange of the pectoral, is nearly smooth, while the asperities are most numerous, and largest, along the anterior margin.

There is thus between adult males and females only that difference in the development of the asperities of the disk which is characteristic of the genus.

The colour of the upper surface is a cold sepia, lightest on the head, except at the end of the snout. There are about 20 rather ill-defined roundish spots on the fleshy part of each wing. Each spot has a small pale yellow centre, from which the colour shades through yellowish-white into that of the general surface of the disk, the whole area of each spot being about three-eighth inch in diameter. The juncture of the anterior limb of the pectoral to the head is outlined, from opposite the eye forwards, by a row of black punctures. Similar punctures extend along the anterior margin, and are present in a small group near the posterior extremity of the pectoral. There are no dark pigment patches whatever; the under surface is an uniform grey, with black punctures.

A number of specimens of both sex, from Rockall, agree with the Iceland examples in the general arrangement of the pigment, but the prevailing colour is grey rather than brown, while the spots are whitish. The water on the "flat of the rock," where these specimens were probably caught, is from 30 to 40 fathoms deep, but it is quite possible that some may have come from much deeper water.

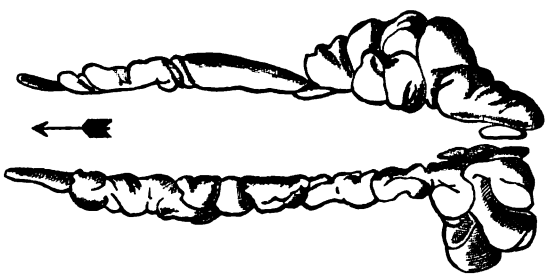
Teeth.—Day remarks that there are about 46 rows in the upper jaw, but does not say to what size of specimen this statement may apply. The specimen he figured was about 28 inches across the disk, if the scale of the drawing is correctly stated. The smallest example we have described has 38 rows, the larger teeth measuring about 1·4 mm. across the base. There is a short pointed central cusp, very feebly keeled in front, and a well-defined shoulder on each side. The 50 inch example from deep water has 48 rows in the upper jaw.

The Iceland male specimen has only 38 rows in the upper jaw, which is rather remarkable in view of the large size of the specimen. In the central part of the jaws the cusps are elongated, sharply pointed, and strongly keeled in front, and the shoulder fairly well-marked. These characters are less conspicuous in the lateral teeth.

Colours.—The grey of the undersurface was well marked in all living examples which we have seen, and is not, as is frequently the case in *R. batis*, the effect of *post-mortem* changes.

Breeding.—We have never recognised the egg-purse of this species, nor does it appear to have been described by other observers.

Kidneys.—We have examined these organs in two females, measuring respectively 36 and 22½ inches across the disk. In both examples they are asymmetrical, especially in the posterior region. The subjoined figure shows the condition in the larger fish, and in the smaller one the conformation is very similar, though not exactly the same. Attention has been drawn by Professor Howes ("Jour. Anat. and Phys." xiv., p. 341) to the frequency of asymmetry in the kidneys of *R. clavata*. The author figures several examples (Pl. XVII.), which in no case very closely resemble those before us, and suggests that the variation may represent the inception of a "condition to be sooner or later seized upon, and handed down to future generations of thornbacks as an inheritance of the past" (*op. cit.*, p. 421). From the examination of only two specimens it is impossible for us to say whether the character has become fixed in *R. oxyrhynchus*, or whether we have merely happened to remark two abnormal examples.



Kidneys of *R. oxyrhynchus*. Half natural size.

Raia fullonica, Linnæus. The Shagreen Ray. (Deep-sea).

Raia fullonica, ... COLLETT, "Norges Fiske," p. 217.
" " . . . . GÜNTHER, "Proc. R. S. E.," xv., p. 206.

A specimen measuring 44 inches in length was taken at 154 fathoms, off Achill Head, on the 20th April, 1891. Others occurred at various depths between 32 and 80 fathoms, while one was caught in Killybegs outer harbour at 14 to 16 fathoms.

The species is known to occur at depths ranging from 80 to 250 fathoms on the coast of Norway (Collett), and Günther has recorded an example from 100 fathoms in Loch Fyne.

It occurs commonly on the Faroe "banks," and off the coast of Iceland, but we are not certain that it has been taken below the 100-fathom line in these localities. The southern limit of its known horizontal range is Madeira. In the British Islands it appears to be more plentiful on the coast of Devonshire than elsewhere; it is certainly not abundant on the east coast, but Couch* has recorded examples from 50 fathoms in the Moray Firth, while a single specimen has been met with by one of us in the shallow water of Findhorn Bay in that locality. On the whole the Shagreen Ray would appear like *R. oxyrhynchus*, to affect rather deep water around the British coast.

Raia microcellata (Montague). The Owl Ray. (Littoral).

Raia microcellata, . . .	Montagu, "Wern. Mem.," ii., p. 430.
,, ,, . . .	Fleming, p. 171.
,, ,, . . .	Jenyns, "Manual," p. 515.
,, ,, . . .	Müller & Henle, p. 142.
,, ,, . . .	Yarrell, "Brit. Fishes" (ed. 3), ii., p. 567.
,, ,, . . .	Day, "Fish. Great Brit.," ii., p. 346.
,, ,, . . .	Moreau, "Poiss. de la France," i., p. 417.
,, ,, . . .	Holt, "Report. Roy. Dub. Soc.," 1892, p. 305.
Painted Ray, ...	Couch, "Fish. Brit. Isles," i,, p. 107.

Diagnosis of Species.—Anterior edge of the disk slightly undulating, scarcely passing in front of a straight line drawn from tip of snout to angle of pectoral fin. Extremity of snout projecting slightly. Width of the disk about 26 per cent. greater than its length, and about 30 per cent. less than the total length, which is about 7 times the length of the snout. Length of the eye about $5\frac{1}{2}$ times in the length of the snout, and from 2 to $3\frac{1}{2}$ times in the distance between the interorbital ridges. Spinacles of greater diameter than, and placed close to, the eyes.

Teeth of adult males pointed, of females obtuse. Both upper and under-surfaces of disk and tail covered with asperities. A median dorso-caudal row of spines in both sexes. Two lateral caudal rows in females; adult males with a single lateral row, always very imperfect, frequently altogether absent either on one or both sides. *Colours*—upper surface brown, inclining to madder or lilac, with a number of pale purplish streaks and spots arranged, on the wings, in a manner roughly parallel to the anterior and posterior margins of the disk: a few pale blotches over the abdomen, frequently accompanied by darker markings.†

* "British Fishes," i., p. 118. † All markings are lost in specimens preserved in alcohol, or by drying.

Large examples may be uniformly coloured. Under surface white. The *linear spines* of the back differ from those of other species known to us in their comparatively small size, and greater abundance. The median row may be said to commence just opposite the posterior margin of the spiracles, as in this region there is noticeable an aggregation of very minute spines, hardly larger than the asperities of the general surface. These minute spines, passing backwards along the middle line, increase gradually in size, but cannot be said to become conspicuous as linear spines until the pectoral region is reached. Throughout the whole length of the median row the spines continue to be crowded together in somewhat the same manner as the spinules of the supra-orbital ridges in many species, and frequently, by overlapping each other, present a zigzag arrangement.

Although attention was specially directed to this species during the survey, as previously unfamiliar to us, we were never able to obtain specimens of less than 16 inches across the disk. All our material being therefore adult, or nearly so, it is impossible for us to speak of any changes of spinulation which may take place during the younger stages. From the very different character of the adult caudal spinulation in males and females, to which we have already alluded in our introductory remarks (p. 381), it is very evident that some changes do occur. A female, 12 inches across the disk, is depicted by Day (*op. cit.*, Pl. clxxii.) This specimen has no lateral caudal spines at all. It would therefore appear that the condition of spinulation exhibited by our specimens is characteristic of adults only, the lateral spines, as in the case of *R. batis*, being only developed late in life. Such a hypothesis may receive some further support from the embryo figured by Couch (*op. cit.*, p. 109), in which, as in very young *R. batis*, there is a single median row only. The larger specimen described by the same author had a single lateral row. It measured 24 inches across the disk, and appears to have been a female. Day remarks that the general surface is occasionally quite smooth, which may very probably be the case in young examples. He also says, on the authority of some person not specified, that old examples may have the upper surface of an uniform grey colour. All the survey examples, however, were marked in the manner indicated in the diagnosis.

Fourteen examples were taken during the survey, viz. one in Blacksod Bay, four in Loughrosmore Bay, and nine in Boylach Bay. The last two bays are contiguous. The depth of water varied from 5 to 19 fathoms. It seems, therefore, that the owl ray is extremely local on the Irish coast, as it is too conspicuous a species to have been overlooked if it had been captured elsewhere. It seems to be essentially an inshore fish, and, previous to the survey, was not known to inhabit Irish waters. It occurs also on the south coast of England, and on the coast of France.

Our largest example was a female measuring 23¾ inches across the disk, and 34 inches in total length. We give a figure of an egg-case taken from this example. It measures 9.10 cm. long, by 5·7 cm. broad. Plate XLIV., fig. iv.

Raia circularis (Günther). The Sandy Ray. (Deep-sea).

Raia circularis, ...	GÜNTHER, "Cat. Fish. Brit. Mus.," viii. p. 462.
„ „	COUCH, "Charlesw. Mag. Nat. Hist.," 1838. ii., p. 71.
(Sandy Ray) *Raia circularis*, .	COUCH, "Fish. Brit. Isles," i., p. 115.
(Cuckoo Ray) *Raia miraletus*, .	COUCH, "Fish. Brit. Isles," i., p. 112.

Couch, in describing the sandy and cuckoo rays as distinct species, based his diagnosis on the well-known differences in the colouration. The sandy ray is uniformly chocolate-brown on the upper side, save for a very few small white spots on the wings, while the cuckoo ray is a pale yellowish-brown, with a very distinct large black and yellow ocellus on each wing.

Dr. Günther, failing to recognise any distinctions of specific value, associated the two forms under the name *R. circularis*, the specific name given to the sandy ray by Couch (*loc. cit.*), and his example has since been followed by all writers of note.*

The material obtained during the Survey affords no reason for combating this arrangement, but it may be as well to state to which colour variety the different specimens belong.

The species is generally distributed along the west coast of Europe, and in the Mediterranean. It has been recorded by Collett,† from a maximum depth of 370 fathoms off the coast of Norway, and by Günther, from 516 fathoms in the Farœ channel, who has drawn attention to the peculiar colouration of the specimen obtained on that occasion.‡ The lower parts are described as "nearly uniform blackish-brown." Our own examples, from deep water, had the under-surface white, as usual. So far as we are aware, no examples answering to the description of the cuckoo ray have been taken in very deep water, whereas the sandy ray occurs in quite shallow water, as well as considerable depth.

We believe that the egg-case of *R. circularis* has never been figured, and therefore append a drawing. Plate XLIV., fig. iii.

* Including Collett, "Norg. Fisk.," p. 214; Moreau, "Poiss. Franc.," i., p. 397; Day, "Fish. Gt. Brit.," ii., p. 348; and Lilljeborg, "Sverig. o. Norg. Fisk.," p. 564.

† "Mag. f. Naturvid.," xxix., p. 119.

‡ "Chall.," xxii., p. 8.

Raia blanda (nobis). The Blonde. (Littoral).

Raia blanda (H. & C., *M.S.*),	HOLT, "Journ. Marine Biol. Assoc.," vol. iii., No. 3, p. 181.
Raia maculata (part), . . .	COUCH, "Brit. Fish.," p. 104.
,, ,, (part), . . .	DAY, "Fish. Great Brit.," ii., p. 345, pl. clxxii.
Raia asterias (part), . . .	MOREAU, "Poiss. Franc."
Raia brachyura (?), . . .	LAFONT, "Soc. Linn. Bord.," xxviii., 1873, pl. 25.

DIAGNOSIS OF SPECIES.—Reaches a width of over 30 inches. Males become mature at a width of about 24 inches. The egg-purse has a length of about $5\frac{1}{2}$ inches, exclusive of attachment processes. Anterior profile obtusely rounded, the extremity of the snout projecting as a short *semicircular* process, except in adult males, where it is more or less conical. Anterior margin of disk twice projecting in front of a line drawn from the tip of the snout to the angle of the pectoral fin, the convexities most marked in adult males; the outer margin would meet at about a right angle. Width of the disk about 25 per cent. greater than in its length, and about 30 per cent. less than the total length; the tail slightly the longer in the male. The distance between the nostrils equal to, or rather less than their distance from the snout. The length of the snout from $4\frac{3}{4}$ (in young) to nearly $5\frac{1}{2}$ times (in adults), and the distance between the tip of the snout and the anterior edge of the coracoid from $2\frac{1}{2}$ (in young) to $2\frac{6}{11}$ times (in adults) in the width of the disk. The length of the eye from $1\frac{1}{2}$ times (in young) to twice (in adults), in the distance between the supra-orbital ridges, which is equal to, or (in large examples) greater than the combined length of the eye and spiracle. Teeth small, obtuse in females and in immature males; sharply pointed in adult males; arranged in from less than 60 to over 90 rows in the upper jaw, as follows:—

In specimens about 9 inches across the disk, about							66	rows.
,,	,,	,,	16	,,	,,	,,	74	,,
,,	,,	,,	23	,,	,,	,,	78	,,
,,	,,	,,	29	,,	,,	,,	93	,,

The supra-orbital ridges have usually a few small spines at each end. Small spines along the rostral ridges, and a spine on each shoulder in young, and sometimes in half-grown, examples. A row of spines runs along the median dorsal line from behind the head. *In young examples three or four spines of this row are in front of the shoulder.* In half-grown and adult examples spines frequently are absent from in front of the shoulder; if present, very small. In males they are usually absent from in front of the pelvic region. A row of spines is situated on each

side of the tail in young examples; irregularly double in its anterior region in adult females, may be absent in half-grown examples of either sex; usually absent or incomplete in adult males.

Small asperities are confined to the prepectoral region of the disk in young examples. They *extend all over the upper surface*, in half-grown examples of either sex and in adult females. The anterior flange of the pelvic in females, and the whole of the pelvic in males, is smooth. The gill-region and central part of the pectoral is smooth in adult males. Asperities are nowhere very clearly set except on supra-orbital ridges and along anterior margin.

The under surface in examples of either sex, 9 inches or more across the disk, shows a *border of very close, backwardly directed asperities along the anterior margin*, not extending to the angles of the pectoral. Scattered asperities extend from the central part of this border over the interhuial region in adult males; less frequently in adult females. A narrow border of closely-set asperities along the edge of the tail in examples of 10 inches or more across the disk. Some asperities about the region of the coracoid and anterior part of the abdominal cavity in half-grown examples of either sex, and about the general surface of the tail in females. Adult females with scattered asperities over the general ventral surface, except the outer parts of the pectoral and pelvic fins.

Colours.—The upper surface a pale fawn, may incline to chestnut, rarely to cold sepia; usually darker on the abdominal region and lighter on the head than on the rest of the body. Thickly sprinkled with small dark spots, seldom exceeding quarter of an inch in diameter, *which extend to the margins of the disk.* A number of small pale, rounded areas, having a certain bilateral symmetry of arrangement, on the wings; rarely with a central dark "pupil" spot; surrounded by a ring of spots never much larger than the rest, and *never continuous with each other.* Transverse pale streaks, destitute of spots, may be present near the margins of the disk. Under surface white, occasionally brown on the projection of the snout.

The existence of two species of spotted rays in British waters was first suspected by one of us during the cruise of the "Harlequin," when it was noticed that the fish taken in Blacksod Bay and several other localities seemed to fall into two groups, one consisting of large, pale, small-spotted individuals, while the rest were smaller, darker, and usually with larger and less numerous spots. It was also noticed that the larger fish yielded an egg-purse twice the size of any that were obtained from the smaller. Differences in external characters were carefully noted, but a difficulty in separating the two kinds arose from the impossibility of obtaining small examples of the pale, small-spotted fish. Hence, though a strong opinion might be formed as to the specific distinction, it seemed impossible to prove to the satisfaction of readers that the condition exhibited by the larger fish

might not be arrived at through stages in which there were no possibility of distinguishing the two, and, therefore, that such difference as existed was of specific rather than varietal value. Accordingly, in drawing up the preliminary reports, no attempt was made to separate the pale from the dark fish (though some allusion was made to the matter),* and, indeed, it would have been impossible to do so with even approximate correctness.

In discussing the matter with Dr. Günther, to whom we are indebted for much valuable advice and information in connection with this Paper, he expressed the opinion that there must be two species, and referred to a record by Dr. Day of the occurrence in British waters of a ray designated by him as *R. punctata* (Risso) Dr. Günther considered the identification incorrect, and the record is further confused by a want of agreement between the description and the specimen in Day's collection to which it appears to refer.†

The description makes the teeth "larger" than in the Homelyn, whereas they are in reality smaller, and in this, as in other respects, the specimen agrees with the large pale forms from the west of Ireland. Owing to the great size it was only possible to preserve the jaws of some of these examples, and even in this respect our material is less complete than might be wished. Fortunately, however, we have again met with the fish in the North Sea, and have obtained a series which puts its specific distinctness from the Homelyn beyond doubt.

The two species are sufficiently unlike each other, at equal sizes, to be distinguished at a glance, but the distinctive characters do not admit of very terse definition, and the diagnosis which we have drawn up is accordingly somewhat unweildy. Still, long as it is, we think there it need of a few further remarks.

The colouration, no doubt, is the feature which most readily arrests the eye in any species, and that of the Blonde (a vernacular designation) differs conspicuously from that of many Homelyns, in that the ground is paler and the spots smaller, more numerous, and more universally distributed than in the Homelyn. Among fish taken on the same ground, and quite fresh, the Blondes, and especially the large ones, are always paler than the Homelyns; but, in a casual market assortment, from various grounds and in various stages of freshness, this difference is not invariably apparent. The spots are never so large in the Blonde as they may be in the Homelyn, and are always close together; but we have seen a Homelyn that could not be distinguished from a Blonde by these markings alone. Moreover the spots came very close to the margin of the disk, the unspotted border being very much narrower than is usual in this species; still, they did not actually reach the posterior margin of the wing, as they always appear to do in Blondes. The

* Holt, "Sci. Proc. Roy. Dub. Soc.," vol. vii., 1892, p. 427.

† The specimen was not labelled at the time it came into the possession of the British Museum. Its identity with the specimen described must therefore remain in doubt.

value of the alar ocelli as a specific character is difficult to express succinctly; but it may be said that all Blondes have a number (about five or more) of small pale circular areas on each wing, which can readily be seen, and which, in fact, cannot escape observation, whereas in the Homelyn, if conspicuous ocelli exist at all, there is only one on each wing (in the position in which an ocellus is found in the young of every species of ray with which we are acquainted), and any other pale areas that may exist require a more careful search, and, when found, are seen to lack the definite rings of spots which invariably encircle their homologues in the Blonde.

The shortness of the rostral projection in the Blonde imparts to the anterior profile a shovel-like appearance which is wanting in the Homelyn. In the shape of the disk, in fact, the Blonde resembles *R. microcellata* more than the Homelyn, and the difference is especially noticeable when specimens of about the same size are compared. As we have noted in our introductory remarks the anterior margin of the wing becomes more sinuous with age, and Homelyns are always more advanced in adult characters than Blondes of corresponding size, since *R. maculata* is by far the smaller species. Of course the difference is most marked when a mature male Homelyn is compared with a male Blonde of the same size and consequently immature. An old male Homelyn has a snout somewhat resembling that of *R. fullonica*, though, of course, shorter, whereas in even the oldest male Blondes the tip of the rostrum is merely a broad cone; its sides practically continuous with the anterior convexity of the front margin of the wing. The smallest Blonde we have seen measures a little less than nine inches across. Very small specimens probably resemble young Homelyns pretty closely, as far as the shape is concerned; and indeed this character is much alike in the youngest stages of all the short-nosed rays.

The smaller size of the eye, and the difference in its relations to the width between the supra-orbital ridges is apparent enough where specimens of the same size are concerned. The other differences of proportion are most readily brought out by measurement, and do not appeal at once to the eye.

The formula of the linear spines is identical in the two species, but of course the difference in ultimate size involves a difference in the development of the spines when examples of the same size are compared. Thus, the large spines which replace the original lateral caudal row of the young ray, may have made their appearance in a Homelyn only 12 inches across, and may be, or, perhaps, always are still absent in a Blonde with a transverse measurement of 18 inches. Further, if specimens of about 9 inches be compared, the spines will be found the smaller in the Blonde, and their bases seem always to have a yellowish tinge, not observable in those of the Homelyn. The presence of more than two spines in the middle line in front of the shoulder in young Blondes seems to be a character of

constant specific value. It is only in old Homelyns that more than two may occur in this region, and they seem to be always very small, in fact not much larger than the surrounding spinules. They belong to the secondary series, and may occur also in old or half-grown Blondes. In Homelyns exceeding 12 inches in transverse measurement it is unusual to find shoulder spines; in the Blonde these structures would seem to disappear, as a rule, when the disk is at a width of about 14 inches; but we have seen a specimen, 38 inches long, and therefore, probably, about 26 inches wide, in which they were still retained. The smaller spines and larger spinules have distinctly radiate bases in young examples of either species.

In the Blonde the upper surface becomes practically covered with spinules when the disk is a width of 16 inches, the smooth condition of certain areas in the adult male being only attained, or rather re-attained, at a size which the Homelyn never reaches. The spinules are never very clearly set, except in certain regions mentioned in the diagnosis, and thus differ from those covering the general surface in *R. clavata*, *R. microcellata*, and some other species.

On the under surface, *the border of very closely-set spinules along the anterior margin*, is an infallible character, since such is never present in the Homelyn at all.* In Blondes of a little under 9 inches it is perfectly distinct, though narrow; it extends laterally to the level of the gills. In specimens of about 18 inches it is about $\frac{5}{16}$ inch wide, except at the lateral extremes, which are narrower, and terminate at points where a straight line drawn through the nostrils would cut the anterior margin. In full-grown Blondes the extremities of the border are approximately on a level with the corners of the mouth. The narrow border of closely set spinules along the edges of the caudal undersurface is another useful character. It is present in all Blondes of 10 inches, and upwards, and entirely absent from any stage of the Homelyn.

In specimens of equal size, *the teeth are always smaller and more numerous* in the Blonde than in the Homelyn; but in both species they seem to vary a good deal both in number and size, apart from the regular developmental changes in these characters. There remains, however, a distinction quite sufficient for systematic purposes, so long as the size of the individual is considered. Thus, a Blonde 9 inches wide has 66 rows; a Homelyn $9\frac{1}{2}$ inches wide, only 49 rows; Blondes $10\frac{1}{2}$ and 11 inches wide have 62 and 66 rows; Homelyns of $11\frac{1}{4}$ and $11\frac{3}{4}$ inches, 51 and 45 rows; a Blonde $16\frac{1}{4}$ inches, 74 rows; a Homelyn, $16\frac{3}{4}$ inches, 51 rows; and another, $17\frac{3}{8}$ inches, only 50 rows. A Blonde, $21\frac{1}{2}$ inches, 74 rows; a Homelyn, $19\frac{1}{4}$ inches, the largest we could procure, 66 rows. The difference here is not great, but we imagine, from comparison with larger and smaller specimens, that the Blonde in question exhibits about the maximum

* It occurs, however, in *R. asterias* (Müll. and Henle), and in *R. punctata* (Risso), and in other spotted rays from the Mediterranean.

degree of reduction in the number of its teeth. Taking specimens of equal size, the largest teeth in the upper jaw seem usually to be nearly one-third larger in the Homelyn than in the Blonde.

The egg-case of the Blonde is easily distinguished from that of the Homelyn by its greater size. Exclusive of the attachment processes, a purse of the Blonde, the parent being 46 inches long, measures 13·6 cm. in length, whereas one taken from a Homelyn, 28 inches long, measures only 6·7 cm. The width of the Blonde's purse is 7·6 cm., the Homelyn's being 4·8 cm. wide. Thus the purse of the Blonde is narrower in proportion to its length, and is moreover more rectangular in shape, the ends especially being almost parallell. There is not much difference in the relative length of the attachment processes in the two species, and the external surface is equally smooth in both. Both egg-cases are figured. Plate XLIV., figs. i. and ii. (Blonde and Homelyn respectively).

DISTRIBUTION.—Blondes were more abundant in Blacksod Bay than elsewhere along the coast, but were taken also in Ballinskelligs Bay, off the Aran Islands, in Clew Bay, and off Downpatrick Head. As we have already remarked, no small specimens were observed anywhere during the Survey, though many were sexually immature. None were taken in more than 29 fathoms, whereas they were frequent in less than 10 fathoms. Homelyns were almost invariably taken wherever Blondes occurred, and it would seem that the two species have much the same *habitat*, though the Homelyn is the commoner of the two, and, as far as our knowledge goes, extends into deeper water off the west coast of Ireland. In the North Sea large Blondes are moderately abundant, and small ones are occasionally taken on certain grounds lying about 20 to 30 miles east of the Spurn, the depth being less than 20 fathoms. Homelyns occur more abundantly on the same grounds. Owing to the confusion of the two species in works on British Ichthyology, it is not easy to learn much of the distribution of the Blonde from such sources, but the fish figured by Day as a Homelyn is certainly a Blonde, and is stated to have come from Plymouth. The specimen of which Couch gives the measurements must also have been a Blonde, so that the species evidently occurs on the Cornish Coast. *R. asterias* of Moreau, which we interpret as comprising both the Blonde and Homelyn, is described as common on all the coasts of France, and also to be found in the Mediterranean. Making allowance for the possibility of only one form, the Homelyn, being possessed of such a wide range, it is still probable that the Blonde extends a considerable distance south of the British Isles. Should it prove to be identical with *R. brachyura*, Lafant, its occurrence will be definitely established on the coast of France.

Names.—The name "Blonde" is that applied by Grimsby fishermen and fish-merchants to *R. blanda*. In advance of ichthyologists, they have long recognized the fish as distinct from the "Homelyn," *R. maculata*. The Blonde, chiefly

on account of its greater size, is of much higher value than the Homelyn, and is also more valuable than the Thornback, though the latter is often quite as large. It is, in fact, one of the most valuable species of Raia which finds its way into the Grimsby market. Young Blondes, on account, as we suppose, of their comparative rarity and low value, are not universally recognised as distinct from adult Homelyns, but there are fishermen and merchants who can distinguish the two forms at all stages. The name is said to have been derived from the Belgian fishermen, but whether this is really the case we have no means of determining. In our choice of a specific name we were actuated by the desire of approaching the vernacular name as closely as possible, while adhering to the ordinary rules of scientific nomenclature. Blanda is an epithet descriptive of mental rather than physical condition, and we cannot claim that in this sense it is actually appropriate. Still, considering the host of closely allied species, the name is probably as distinctive as any that could have been coined from the physical characters of the species.

REMARKS ON THE SYNONOMY.—As is apparent from the synonomy which we have given above, we consider that Blondes and Homelyns have been pretty generally confused by authors who were acquainted with examples of both species.

It is possible that even Montague failed to distinguish between them, since he states that his species *R. maculata* grows to a larger size than *R. clavata*, whereas the Thornback is larger than the Homelyn in any district of which we have experience. If the author regarded the Blonde as merely a large Homelyn, his statement would be perfectly intelligible, but his specific description is evidently taken from the Homelyn, and not from the larger species. Hence we have no hesitation in retaining the name of *R. maculata* for the Homelyn, since the correctness of the diagnosis is not impared by any confusion which may possibly have existed in the mind of the author.

Couch's description is too inexact to enable us to be certain whether it is intended to apply to one species or to both. The specimen selected for special description would appear from its size, and from the roughness of the upper surface, to have been a Blonde, but the colouration of the figure is apparently taken from a Homelyn, and no doubt the author's general remarks are chiefly meant to apply to examples of that species. Day's diagnosis of *R. maculata* refers chiefly to the Homelyn, but from his remarks on the dentition it is evident that he confused that species with the Blonde. Moreover, his figure which, as appears from the text, was taken from an immature male 25 inches across the disk, must certainly have been taken from a Blonde. The author remarks that the spots in this specimen were rather closer together than usual; but it is probable that the drawing does not very accurately represent the original either in markings or some other details.

The *R. asterias* of Moreau appears, so far as that author's somewhat loose mode of expression permits us to judge, to comprise both the Blonde and the Homelyn. It is certainly not the *R. asterias* of Müller and Henle. His description of the border of spines along the anterior margin of the under surface of the disk appears to indicate one of the most pronounced features of the Blonde; but in his description of the dorsal surface, as being almost smooth with slight spinules on the anterior margin of the pectorals, and around the scapular arch, he certainly must have had the appearance frequently found in the Homelyn present to his mind.

Under the name of *R. brachyura*, Lafont* described and figured a spotted ray, which was certainly not a Homelyn, and may possibly have been a Blonde. The description, however, is quite inadequate, while the figure is primitive in the extreme. The formula of the linear species agree with that of either *R. blanda* or *R. maculata*. Six are shown in the median series extending from behind the level of the spiracles to the abdominal region, the series reappearing posteriorly on the tail.

The snout is short, the disk, according to the drawing, rhomboidal, with six large white spots on each wing. Smaller dark spots are universally distributed over the disk, except on the head, but are not shown as surrounding the pale areas. It is noted that the latter have been made rather too conspicuous by the artist. The tail is stated to be broad and flat, and much shorter than the disk, though this last character (as compared with other species) is not brought out by the measurements given. There are said to be eighty-five rows of teeth in the jaws, but the size of the individual from which this observation was taken is not mentioned. The teeth resemble those of the side rows of a young *R. batis*. Certain measurements are given of two specimens, from which it appears that the proportions of the length and breadth of the disk and the length of the tail do not conspicuously differ from those of either the Blonde or the Homelyn. It further appears that the diameter (longitudinal or transverse?) of the eye is contained five and a-half times in the width of the inter-orbital space. The individuals measured are, an immature male 88 cm. long, and as female 113 cm. long.

It is expressly stated that neither spines nor "aiguillons" exist on the under surface, but it is not certain whether these terms can be interpreted to include asperities or minute spinules such as form so well-marked a feature on the under surface of the Blonde. The omission of all reference to such asperities renders it quite impossible to identify *R. brachyura* with *R. blanda*, while the general inadequacy of the description renders it equally impossible to say what species Lafont had before him. It may possibly have been *R. asterias* (Müller and Henle). The specimens were obtained from the Gironde and from Arcachon, where the species is known to fishermen as the *Raia blanche* or *lisse*.

* "Soc. Linn. Bordeaux," xxviii., 1873, p. 503, pl. 25.

Raia maculata, Montagu. The Homelyn. (Littoral.)

Raia maculata, ...	MONTAGU, "Wern. Mem.," ii., p. 426.
,, ,, ...	PARNELL, "Wern. Mem.," vii., p. 434.
,, ,, ...	GUNTHER, "Cat. Fish. Brit. Mus.," viii., p. 458.
,, ,, (part), . .	DAY, "Fish. Grt. Brit.," ii., p. 345 (nec. fig.).
Raia rubus, ...	DONOVAN, "Brit. Fish.," i., pl. xx.
Raia miraletus, ...	DONOVAN, "Brit. Fish.," iv., pl. ciii.
,, ,, ...	JENYNS, "Manual," p. 518.
,, ,, ...	YARRELL, "Brit. Fish." (3rd ed.), ii., p. 570.
Raia asterias (part), . . .	MOREAU, "Poiss. de la Franc.," i. p. 429.
Spotted Ray (part), . . .	COUCH, "Brit. Fish.," i., p. 104.

The following diagnosis is added for the purpose of further emphasising the characters which separate this from the preceding species:—*R. maculata* reaches a width of about twenty inches across the disk. Males become mature at a width of about fifteen inches (or less?). The egg-case about two and a-half inches long, exclusive of attachment processes, is seen in Plate XLIV., fig. ii.

The extremity of the snout slightly projecting; rounded in young, conical in half-grown and adult examples; rather sharply-pointed in old males. Anterior margin of disk twice projecting in front of a straight line drawn from the tip of the snout to the angle of the pectoral fin; the convexities most apparent in adults, especially males.

The distance between the supra-orbital ridges equal to the length of the eye in young; one-third greater than that measurement in adults; never greater than the combined length of the eye and spiracle.

The length of the snout from $5\frac{1}{3}$ to $5\frac{1}{2}$ times, and the distance between the tip of the snout and the anterior edge of the coracoid from $2\frac{3}{4}$ in young to $2\frac{3}{5}$ times, in adults, in the width of the disk.

The supra-orbital ridges usually with two spines at each end. A row of spines along the median line from behind the head, the last spine usually between the dorsal fins. *In young examples only two species of this row are in front of the level of the shoulder.* In half-grown and adult examples spines usually absent from in front of the shoulder; if present, very small; in males usually absent from in front of the pelvic region. A row of spines on each side of the tail in young examples; may be absent in half-grown examples; usually incomplete or absent in adult males; irregularly double in its anterior third in large females. Small spines along the rostral ridges, and a spine on each shoulder in young examples.

Small asperities confined to the pre-pectoral region of the disk in young examples. Present on the inter-orbital space, rostrum, distal part of anterior half of pectoral fins and tail in adults of both sexes. In *adult females* the whole of the upper surface rough, except the gill region, central part and posterior margin of pectoral fins, and pelvic fins.

The under surface perfectly smooth in young examples, and in adult males, except a few spinules on the snout and along anterior margin. In adult females a few asperities may be present on the coracoid, about the gill openings, and along the anterior border of the abdominal cavity. The under surface of the tail also with scattered asperities.

There is never a ventral border of closely-set asperities along the anterior margins, nor along the edges of the tail.

Teeth obtuse in females and immature males; sharply-pointed in adult males, of moderate size, arranged in about 20 to 70 rows in the upper jaw.

In specimens	of about	4	inches	across the disk	about	23	rows.
,,	,,	,,	9–14	,,	,,	,,	45–50	,,
,,	,,	,,	19	,,	,,	,,	66	,,

Colours.—The upper surface usually a yellowish brown or cold sepia, rarely a greyish chocolate or dark grey. Dark brown spots more or less plentifully distributed, always absent from the posterior margin of the wing, and usually from its immediate neighbourhood. In rare cases altogether absent. In half-grown and young adult examples frequently a distinct and rather large pale ocellus on the wing, with or without a dark "pupil" spot, and *surrounded by a ring of spots, and more or less continuous with each other.* Smaller and less distinct pale areas, not surrounded by definite rings of spots, may be present elsewhere on the wings. Under-surface white.

Distribution.—The Homelyn was found during the Survey all along the west coast. The greatest depth recorded is 48 fathoms, in the Kenmare River, but the majority were taken in less than 30 fathoms. It appears to be generally distributed on all the coasts of Great Britain, and occurs also on the coast of France. It has not been found in Scandinavian waters. Moreau describes his *R. asterias* as not only common on all the coasts of France, but as sufficiently common in the Mediterranean.

TELEOSTEI.

Family PERCIDÆ.

Genus **Pomatomus**, Risso (*nec* Lecép).

"Eye very large, seven branchiostegals. All the teeth villiform, without canines, no teeth on the palatine bones. Two dorsals, separated by an interspace, the first with seven, the anal fin with two spines. No denticulations on the edges of the bones of the skull, operculum, with two very feeble points, preoperculum with prominent rounded and striated angle. Scales moderate, slightly adherent. *Pancreatic caeca* in considerable numbers." (Günther.)

Pomatomus telescopium, Risso. (Deep-sea).

(Pl. XLII., figs. 3, 3*a*, 3*b*, 3*c*.)

Pomatomus telescopium,	. . .	RISSO, "Ichth. Nice.," 1810, p. 301.
,, ,,	. . .	CUV. ET VAL., "Hist. Nat. Poissons," vol. ii., p. 171, and vol. vi., p. 495.
,, ,,	. . .	VALENCIENNES, "Hist. Nat. Iles. Canar. Poiss.," p. 6.
,, ,,	. . .	LOWE, "Proc. Zool. Soc. Lond.," 1843, p. 91.
,, ,,	. . .	GÜNTHER, "Cat. Fish. Brit. Mus.," vol. i., p. 250.
,, ,,	. . .	MOREAU, "Poiss. de Franc.," vol. ii., p. 386.
Pomatomus telescopus,	. . .	VAILLANT. "Exp. Sci. 'Travailleur' et 'Talisman,' Poiss.," 1888, p. 376.
Pomatomus telescopium,	. . .	HOLT, "Proc. Roy. Dub. Soc.," vol. vii., p. 121.

Br. vii.; D. i. 7; D. ii. 1/10–11; P. 18; A. 11–12; L. lat. 40–53.*

DIAGNOSIS OF SPECIES.—Length of head about $2\frac{3}{4}$ times in length of fish without caudal fin; greater than extreme height of body. Diameter of eye more than $\frac{1}{3}$ length of head, slightly greater than length of snout. Interorbital space wide. A well-marked transverse depression in front of interorbital space. Lower jaw the longer. Maxilla extends to about level of centre of eye. Upper jaw protrusible. Membrane of mouth ample. Anal papilla rather protuberant, slightly anterior to median point. All fins rather small. Scales large, very

* Günther, Cat. makes L. lat. 40. We count 53 in our specimens.

thin, ctenoid, deciduous. Small scales present on the head and fins (except first dorsal). Colouratian variable, prevailing tone pale slate-grey; somewhat darker on fins, and on gill cover, which exhibit a purplish sheen. Darker examples become brown or moroon grey. Branchiostegal, and mouth membranes deep black. Eye green. In alcohol, pale specimens assume a purplish hue.

Distribution.—Risso, in his original description does not state the depths from which he obtained his specimens, merely remarking that it inhabits "les grande profundeurs." Max Webber and Berthelot obtained the specimens studied by Valencinnes from depths of 250 fathoms. The examples procured during the cruises of the "Travailleur," and the "Talisman," described by Vaillant, came from depths varying from 222 to 527 fathoms.

As the species seems never to have been recorded from less depths, we may conclude that it is confined exclusively to deep water.

Two specimens, measuring respectively 20·3 cm. (8 inches), and 12·7 cm. (5 inches), were taken by trawl net, on the 4th July, 1890, in 144 fathoms, 20 miles off Achill Head, county Mayo.

This is the first appearance of the species in British waters, and since it has never been taken by any dredging expedition in higher latitudes, this record of its capture may probably mark the northern limit of its range.

The researches of Risso, Valenciennes, Lowe, and Vaillant show that the species has its habitat along the Atlantic slope of the old Hemisphere from the Bay of Biscay to the Island of St. Helena, and occurs also in the Mediterranean, off Nice, and in the Straits of Messina. It is known to attain to a length of 2 feet, and is said to spawn off St. Helena in November. (Valenciennes.)

Anatomy.—A careful description of the visceral anatomy is given by Cuvier and Valenciennes, and agrees for the most part with the condition exhibited by our specimens. These authors, however, remark that the gall-bladder is large and hidden by the right lobe of the liver. In the specimens before us the gall-bladder, so far from being hidden by either lobe of the liver, extends well beyond the posterior extremity of the stomach, and in fact as far back as the commencement of the rectum. It is roughly tetragonal in section in the region of its greatest expansion, but nowhere attains any great width. Günther ("Challenger," vol. xxii. p. 14, fig. 1), has noted an even greater development of the gall-bladder in another deep-sea perch, *Scombrops chilodopteroides*, Blkr., in which that organ actually reaches the posterior extremity of the visceral cavity. He also notes, as a feature of interest, that the intestine only makes one complete convolution. This is also true of Pomatomus, but the intestine is somewhat longer than in Scombrops, a result chiefly attained by a short secondary infolding of the curved region of the duodenum. The stomach is large and simple, the pyloric coeca, twenty-two in number, of moderate length; the rectum inflated; the anal papilla protuberant,

a condition not usually met with in percoid fishes. The air-bladder is large, forming the dorsal wall of the whole of the visceral cavity. The urocyst is spherical and rather thick-walled. Both specimens are immature males, the testes appearing as narrow bands attached to the ventral wall of the air-bladder on either side. We have not been able to detect the spleen, if that organ exists. A considerable amount of fatty matter adheres, in the large specimens, to the hæmorrhoidal vein.

A small vein, which occupies the usual position of the lienic, appears to receive part of the blood from the *rete mirabile*, but the greater part of the blood from that structure is received by a larger and more anterior vein, which, after uniting with the left spermatic, enters the Cuverian sinus. At the point of juncture of the two veins last mentioned, there is in one larger specimen, an anastomosis between the two venous systems, by means of a branch which leaves the portal vein just before the latter splits up to enter the liver. The arterial system of the visceral cavity presents no points of interest.

DESCRIPTION OF SPECIMENS.—*Scales.*—The rather large, deciduous scales are typically ctenoid, but very thin and semi-transparent. In a scale from the neighbourhood of the lateral line about the central region of the body the whole of the exposed surface is beset by fine spines, arranged in about seven rows from before backwards (Pl. XLII. fig. 3 *a*). The spines of the third and sixth rows are the longest, whilst those at the extreme posterior edge are the stoutest. Each spine is attached to the body of the scale for the greater part of its length, having only a short free portion posteriorly resembling an arrow-head in shape (fig. 3 *b*). The spines of the lateral line scales (fig. 3 *c*) are few and feeble. Both examples were almost entirely denuded of scales by the time they came on board,* but from those which remained, and from the distinctness of the scale insertions, we believe that we have been able in fig. 3 to reproduce the natural condition with tolerable accuracy so far as concerns the body itself. The lateral line scales were mostly *in situ*, but are perhaps shown in the figure with too great distinctness. Whilst all the other fins were evidently covered with small scales in their basal regions, the first dorsal seems to have been scaleless. It is difficult to judge to what extent the head is clothed with scales in the natural condition, and it is possible that the keel of the pre-operculum, conspicuous in the specimens in their present state, may be really marked in life by a continuous scaly integrement.

Lateral line.—We find fifty-three scales in our specimens. The number given by Günther in the Catalogue is forty, so that considerable variation would appear to exist in this respect.

* A result probably attributable to the presence of an enormous number of *Spatangus Raschii* in the net.

Colour.—Both specimens evidently belong to the pale variety mentioned by Lowe. In the fresh condition, the body was of an uniform pale slate-grey, the head similar, except on the gill cover, which was rather darker, with purplish "reflêts," and might well be described by Valenciennes' expression "gorge du pigeon." The membranous folds of the jaw apparatus and the branchiostegal membranes were black; the fins dark grey. The action of alcohol has changed the general colour to a dark purplish grey.

In the fresh condition the eye appeared like a hemisphere of bright green glass, a condition common to the eyes of many abysmal species. No trace of internal structure, such as has inadvertently been shown in the drawing, was visible at the time of capture.

Genus **Polyprion**, Cuvier.

Polyprion cernium, Valenciennes. The Wreck-fish. (Deep-sea.)

Polyprion cernium, ... Lowe, "Fish Maderia.," p. 183.
,, ,, ... Day, "Fish. Gt. Brit.," i., p. 17.

No examples were met with during the Survey. The fish has a very wide range, and has occurred off the south-west coast of Ireland, and more frequently off the south coast of England. Such specimens appear to have been usually, if not always, found in the neighbourhood of floating wreckage, and were all of comparatively small size. This is intelligible from Lowe's observation that the young live near the surface, while the largest are taken (at Madeira) at depths of 300 to 400 fathoms.

Genus **Scorpæna**, Günther.*

Head large, slightly compressed, usually with a naked groove in the occiput, armed with spines, and generally with skinny flaps; body covered with scales of moderate or rather large size, generally with skinny appendages. One dorsal, more or less deeply notched. Pelvics, thoracic; pectorals large, rounded, inferior rays frequently thickened; no pectoral appendage. Villiform teeth in the jaws, on the vomer, and generally on the palatine bones. Seven branchiostegals; not more than 25 vertebræ. No air-bladder. Pyloric coeca in moderate numbers.

* We have endeavoured to remodel the generic diagnosis in accordance with Dr. Günther's remarks in "Fisch. d. Südsee," p. 74.

Scorpæna dactyloptera, Delaroche. (Deep-sea.)

(Pl. XLII., fig. 1.)

Scorpæna dactyloptera, . .	DELAROCHE, "Ann. Mus.," xiii., pl. 22, fig. 2.
,, ,, . .	RISSO, "Ichth. Nice," p. 186; and "Faun. Eur. Mérid," iii., p. 369.
,, ,, . .	GÜNTHER, "Ann. Mag. Nat. Hist.," 1889, p. 417.
,, ,, . .	HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 121 and 219.
,, ,, . .	EAGLE CLARKE, "Naturalist," 1893, p. 81.
,, ,, . .	HOLT, "Jour. M. B. Assoc.," 1893, 121.
Sebastes dactylopterus, . . .	GÜNTHER, "Cat. Fish. Brit. Mus.," ii., p. 99.
,, ,, . . .	VAILLANT, "Exp. Sci. 'Talis.' 'Trav.' Poiss.," p. 368.
,, ,, . . .	SCHARFF, "Proc. R. I. Acad.," 1891, p. 456.
,, ,, . . .	COLLETT, "Norg. Fish," p. 19.
,, ,, . . .	LILLJEBORG, "Sver. o. Norg. Fisk.," i., p. 107.
Sebastes imperialis, ...	CUVIER & VALENCIENNES, iv., p. 336.
,, ,, ...	LOWE, "Trans. Zool. Soc. L.," ii., p. 175.
Sebastes norvegicus, ...	SCHARFF, "Cat. Fish. Mus. Dub.," 1889, p. 26.

DIAGNOSIS OF SPECIES (D. i. 11–12; D. ii. 1/ 12–13 A. 3/5).—The height of the body 3¼, the length of the head nearly 3¼, of the total length. The inter-orbital space deeply concave, with two naked bony ridges; its width about one-ninth of the length of the head. Jaws sub-equal, the upper extending behind a vertical line from the centre of the eye. Tongue distinctly free anteriorly. Five spines on the pre-operculum. Pectoral fin with the seven inferior rays thickened, and semi-separate in adults; three to seven pyloric appendages: twenty-four or twenty-five vertebræ.* Colours red, banded with dark-red; or spotted or banded with dark-brown; abdomen pale; pharynx black.

The species has been repeatedly confused with *Sebastes norvegicus*, and for purposes of comparison we have given (Pl. XLII., figs. 1 and 2) an outline drawing of the head of *Sebastes norvegicus*, as well as a figure of the species now under consideration. The superior angle of the gill cover is rounded in *Scorpæna dactyloptera*,

* Mr. Sim, of Aberdeen, writing of this species under the name of *Sebastes norvegicus* ("Ann. Scot. Nat. Hist.," 1893, p. 47), gives the number of vertebræ as 25 to 26. One of the Survey specimens has 25, Günther's Catalogue gives the number as 24, and, in remodelling the genera of Sebastes and Scorpæna, this author gives 24 vertebræ as the maximum in the latter. Since, however, *S. dactyloptera* is included in that genus, we have raised the maximum number to 25 (or 26?).

not carried to a point as in the "Norway haddock." The general outline of the head is also more rounded in Scorpæna; and although the original figure of the species given by Delaroche shows the lower jaw projecting beyond the upper, as it does in Sebastes, this appears to be more the exception than the rule. Figures 1*a* and 2*a* show imaginary sections through the interorbital regions of the two species, and it will be noted that while in *Sebastes norvegicus* the space is broad and nearly flat, with hardly perceptible scale-covered ridges, in *Scorpæna dactyloptera* it is comparatively narrow, deeply concave, and beset by a pair of conspicuous naked bony ridges. In *Scorpæna dactyloptera*, also, the serration of the frontal over the superior margin of the eye is much more strongly marked than in *Sebastes norvegicus*. In this form the sub-orbital ridge is broad, obliquely directed, and covered with scales. In *Scorpæna dactyloptera* it is narrow, roughly parallel to the long axis of the body, and entirely naked.* In the last-named, the opening of the gill-cover is almost vertical, while in the "Norway haddock" it is markedly oblique. In addition, the scales in *S. dactyloptera* are considerably the larger.

A difference less conspicuous than any of the foregoing, but of much greater morphological importance, is found in the characters of the pectoral fin. In *Sebastes norvegicus* the rays of this fin are all alike, and united to the extremities; but in the species before us the seven lower rays are stouter than the rest, and in adults are separate for about half their length. The species thus recedes from Sebastes and the true Perches, and approaches the semi-ambulatory condition of the pectorals which characterises the Triglidæ. A number of very young *S. dactyloptera*, measuring from 4 to 4·5 cm. long, taken off the Skelligs at 80 fathoms, have the pectoral fin entire; such is also the case in a specimen of 4¾ in. (12 cm. *ca*) recorded by one of us from the Humber, but all larger examples which we have seen show a partial separation of the lower rays. Our artist has unfortunately treated this detached condition of the rays in the specimen figured as due to artificial causes, and has restored the membrane to the extremities.

With reference to the size at which the fish becomes sexually mature it is interesting to note that a specimen measuring 7½ inches was found to contain ova nearly ready for expulsion. The structure of the reproductive organs seemed to show that the species is oviparous (the "Norway haddock" is viviparous), and it is probable that the ova is pelagic, as in the case of certain Mediterranean species studied by Raffaele. The greatest size reached by the species appears to be about 24 inches, but those from the West of Ireland do not attain to that size. It is likely that the size at which maturity is reached varies somewhat in different localities.

When alive all the larger fish taken during the Survey, exhibited the following colouration:—The back was a brilliant vermilion, which colour descended in five

* Our figure in this respect is in error, scales having been restored where none were actually present.

or six bands across the sides, shading gradually into the pink of the general surface. The under-surface white, or white with a tinge of yellow, shading into pink on the sides. The fins were pink, marked irregularly with vermilion. The iris was bright yellow.

In the very young examples previously alluded to, the transverse bars were dark-brown, and no red colour was present (*teste* Mr. Green) at the time of capture. Some fine adult examples captured off Troup Head, Aberdeenshire, now in the British Museum, show a certain amount of dark-brown in the transverse markings, and thus differ from all the larger Survey specimens. The very young examples have, without exception, a black spot covering the 6th, 7th, and 8th rays of the anterior part of the dorsal fin.

DISTRIBUTION.—*S. dactyloptera*, previously known as an inhabitant of the Scandinavian and Lusitanian areas, and of the southern Atlantic, has recently become established as a truly British species, without doubt breeding and permanently residing around the British shores. The first records of its appearance was given by Dr. Günther in 1889, from specimens taken by the "Flying Fox" at 250 fathoms off the south-west of Ireland. During the Survey, several adults and half-grown specimens were taken off the coasts of Mayo and Kerry at depths of 500, 220, and 154 fathoms, while a great number of young were obtained at 80 fathoms, off the Skelligs. Scharff, in examining several specimens taken by the "Lord Bandon" off the south-west of Ireland, was led to the discovery that a number of fish from the same locality, preserved in the Science and Art Museum, and labelled *Sebastes norvegicus*, belong really to the species now under consideration. It thus appears that *S. dactyloptera* has been captured off the coast as early as 1843, by William Andrews, while the species to which his specimens were referred is actually unknown in Irish waters.

On the English coast the first recorded example was washed ashore at Coatham Sands in Yorkshire in February, 1893 (Eagle Clarke). In April of the same year a specimen was received by one of us from the Humber Estuary, and the accounts of fishermen gave reason to suppose that others had been taken there about the same time. All these English examples were quite small. About the same time it transpired, as we are informed by Mr. Boulanger, that the species had been regularly taken off Troup Head, Aberdeenshire, where the soundings reach a depth of over 130 fathoms, but had previously been mistaken, as in Ireland, for *Sebastes norvegicus*. In Norwegian waters the recorded depth is from 100 to 300 fathoms, and off Madeira from 250 to 400 fathoms, but the species was taken during the expeditions of the "Travailleur" and "Talisman" at 54 to 527 fathoms. It has thus been found almost exclusively in deep, or at least in moderately deep, water, which renders the occurrence of a specimen in less than 5 fathoms in the Humber somewhat remarkable. The example found at Coatham

Sands may presumably have been carried by the tide some way after death, but there is no great depth of water for a very considerable distance in any direction. The Humber specimen was trawled in the ordinary way, and there was nothing to show that its surroundings were uncongenial. Professor Smitt is led by the incompleteness of his compilation ("Hist. Skand. Fish." Ed. iii., 1893, p. 154) to the observation that, north of Portugal, *S. dactyloptera* has never been found south of Norway.

Fam.—BERYCIDÆ.

Genus **Hoplostethus**, Cuv. et Val.

Hoplostethus mediterraneum, Cuv. et Val. (Deep-sea.)

Hoplostethus mediterraneum, . . GÜNTHER, "Ann. Mag. Nat. Hist.," 1889, p. 417.

This species was not met with during the survey, and is only known as British, from the capture of a single specimen by Mr. Green, in the "Flying Fox," off the S.W. of Ireland, at a depth of 250 fathoms. This, according to Dr. Günther, furnished the first exact record of the vertical habitat. Vaillant (*Exp. Sci.*, p. 378) has since announced its occurrence at depths of 75 to 777 fathoms off the coast of Morocco. Its horizontal range is very extensive, since specimens have occurred in the Mediterranean, at Maderia, off the Atlantic coast of the United States, and on the coast of Japan (*cf.* Günther, "Chall." xxii., p. 21).

It may be remarked that another member of the same family, *Beryx decadactylus*, Cuv. et Val., may not improbably occur in deep water within the British area, since examples have been taken off Bergen, in Norway. It is found also off the coast of Portugal, Madeira, the Azores and Canary Islands, and in the sea of Japan.

Fam.—TRICHIURIDÆ.

Genus **Lepidopus**, Gouan.

Lepidopus caudatus, Euphrasen. The Scabbard Fish. (Deep-sea.)

Lepidopus argyreus, ... BALL, "Dublin. Nat. Hist. Rev.," ii., p. 45.

This species, of which a specimen has been recorded by Ball, from Dublin Bay, is included by Dr. Günther in the Challenger Monograph on the deep-sea fishes as "probably an inhabitant of moderate depths, although no positive evidence has been forthcoming as to its vertical distribution."

Genus **Trichiurus**, Linnæus.

Trichiurus lepturus, Linnæus. The Silvery Hairtail. (Deep-sea.)

Trichiurus lepturus, ... ANDREWS, "Proc. Roy. Dub. Soc.," vi., p. 35.
" " . . . . GÜNTHER, "Chall.," vi., p. 66, and xxii., p. 39.

Several examples have occurred on the Irish coast. The Silvery Hairtail is to a great extent pelagic in habit, but was taken by the "Challenger," off Inosima, Japan, in 345 fathoms. Like the last species, it appears to be practically cosmopolitan in its horizontal distribution.

Fam.—**SCOMBRIDÆ.**

Genus **Echeneis**, Artedi.

Echeneis remora, Linnæus. The Sucking Fish.

The head and shoulders of a Sucking Fish were found in the stomach of a Picked dogfish (*Acantheas vulgaris*) taken on the S.W. coast during the survey.

We are thus able to add another to the somewhat scanty records of the occurrence of this fish in British waters.

The late Dr. Day (Fish. Gt. Brit. i. p. 107), considered that "Commerson, and some later writers" had drawn largely on the credulity of their readers in describing the use made of fish of this genus in the capture of turtle on the Mozambique coast. It may therefore be noted that the existence of what appears to be an essentially similar fishery in the Torres Straits has recently been established by the observation of Professor Haddon.

Fam.—**CARANGIDÆ.**

Genus **Capros**, Lacépède.

Capros aper, Linnæus. The Boar Fish. (Deep-sea.)

Capros aper, ... VAILLANT, "Exp. Sci. Trav. Talism. Poiss.," p. 360.
" " . . . . . GÜNTHER, "Ann. Mag. Nat. Hist.," 1889, p. 417.

This species was not met with during the survey. Examples have been recorded by Günther from 180 fathoms off the S.W. coast of Ireland, and by Vaillant from the South Atlantic at a maximum depth of 192 fathoms. The Boar

fish is known to habitually frequent rather deep-water, although, in the neigh bourhood of Plymouth, it is tolerably abundant in depths of less than 30 fathoms during the summer months. In 1887 * Mr. Cunningham artificially fertilized the ovum on 15th August.

Fam.—**CORYPHÆNIDÆ.**

Genus **Schedophilus**, Cocco.

Schedophilus medusophagus, Cocco. (Deep-sea.)

Schedophilus medusophagus, GÜNTHER, "Trans. Zool. Soc. Lond.," xi., 1882, p. 233.

The only known British example of this species was taken in a salmon net at Portrush, Co. Antrim. We are not aware that there exists any record of its occurrence at depths of over 100 fathoms, and, in including it among the deep-sea forms, have been guided merely by the example of Dr. Günther (Chall. xii. p. 46). From the remarks of this anthor it would appear that the various species of the genus are pelagic, though some possess structural characters indicative of a bathybial habitat. *S. medusophagus* has been obtained, in the adult condition, in the Mediterranean and off Samoa, as well as on the Irish coast, while young examples are common at the surface in Mid-Atlantic (Günther).

Fam.—**COTTIDÆ.**

Genus **Cottus**, Artedi.

Cottus quadricornis, Linnæus. (Littoral.)

Cottus quadricornis (?), . . HOLT, "Trans. Roy. Dub. Soc.," N. S., v., p. 117.

The addition of this species to the Irish list rests upon the doubtful identification, by one of us, of certain very young Cotti, taken during the survey in the outer harbour at Killybegs, in Donegal Bay, and off Tory Island.

Fam.—**TRIGLIDÆ.**

Genus **Trigla**, Artedi.

Trigla cuculus, Linnæus. The Red Gurnard. (Deep-sea.)

Trigla pini, ... VAILLANT, "Exp. Sci. Trav. Talism. Poiss.," p. 360.

A specimen is recorded by Vaillant from 164 fathoms (360 metres) in the Bay of Biscay. The species is otherwise known only from littoral waters. Judging from the results of the survey, it is only moderately abundant on the west coast of Ireland.

* "Jour. Mar. Biol. Assoc.," March, 1889.

Trigla lyra, Linnæus. The Piper. (Deep-sea.)

Trigla lyra, ... VAILLANT, "Exp. Sci. Trav. Talism. Poiss.," p. 360.
" " . . . . . HOLT, "Sci. Proc. Roy. Dub. Soc.," viii., pp. 121 and 219.

Two adult specimens were trawled at 144 fathoms off the coast of Mayo, and a young one at 115 fathoms off the coast of Kerry. Other examples occurred during the survey at depths between 24 and 62 fathoms. Vaillant records the capture of a very small specimen from 222 fathoms in the Bay of Biscay.

Fam.—**PEDICULATI.**

Genus **Lophius**, Artedi.

Lophias piscatorius, Linnæus. The Angler. (Deep-sea.)

Lophius piscatorius, . . . BROWN-GOODE, "Proc. U. S. Mus.," iii., 1881, p. 469.
" " . . . BOURNE, "Journ. M. B. Assoc.," N. S., i., p. 310.
" " . . . HOLT, "Sci. Proc. Roy. Dub. Soc.," viii., p. 219.

This species, well-known in littoral waters, appears to be regularly met with also at considerable depths. Thus Bourne obtained a specimen at 200 fathoms on the S.W. coast of Ireland; another was taken during the survey at 115 fathoms, off the coast of Kerry, while three have been recorded by Brown-Goode from the coast of the United States at depths of 120, 142, and 365 fathoms, respectively.

Fam.—**DISCOBOLI.**

Genus **Liparis**, Artedi.

Liparis vulgaris, Fleming. (Deep-sea.)

Liparis vulgaris, . . . GUNTHER, "Ann. Mag. Nat. Hist.," xiii., 1874, p. 139.
" " . . . SCHARFF, "Sci. Proc. Roy. Dub. Soc.," 1891, p. 448.

Dr. Scharff has added this fish to the Irish list since the publication of his Museum Catalogue. It was not recognised during the survey, though it may have occurred among a number of examples of this genus, too young for specific

determination, which have received attention from one of us in a previous number of these Transactions.*

L. vulgaris is not included by Dr. Günther in the Challenger Monograph on Deep-sea fishes, although it had previously been recorded by the same author among the species taken by the "Porcupine" at 180 fathoms in the Faroë Channel. Beyond this, it is only known as a littoral form, but it is interesting to note that it has been taken at a depth of 64 fathoms off the Mull of Cantyre.†

Fam.—BLENNIIDÆ.

Genus **Carelophus**, Kröyer.

Carelophus ascanii, Walbaum. (Deep-sea.)

Carelophus ascanii, . . . Strom, "Norsk. Vid. Selsk. Skr.," 1881, p. 75.
Blenniops ascanii, . . . Günther, "Ann. Mag. Nat. Hist.," 1874, p. 139.
Chirolophus galerita, . . . Smitt, "Hist. Skand. Fish.," ed. ii., p. 218.

This species was not met during the survey, and has only been recorded within the Irish area from shallow water. Specimens have been taken at 180 fathoms in the Faroë Channel (Günther) at 140 fathoms in Trondjheim Fjord (Strom.), while the maximum depth at which it has been known to occur in Norwegian waters appears to be 182 fathoms (Smitt).

Fam.—TRACHYPTERIDÆ.

Genus **Trachypterus**, Gouan.

Trachypterus arcticus, Brünner. The Northern Deal-fish. (Deep-sea.)

Trachypterus arcticus, ... Day (?), "Zool.," February, 1875, p. 4343.

The Deal-fishes are without doubt abysmal in their normal habitat, although, as it happens, only a single example has actually been taken in deep-water (*cf.* Günther, Chall. xxii. pp. 71–72). The species under consideration is represented in Irish records by a single example washed ashore at Bundoran.

* Holt, "Trans. Roy. Dub. Soc.," N. S., v., 1893, p. 35.
† Günther, "Proc. Roy. Soc. Edin.," 1888, xv., p. 211.

Fam.—GOBIIDÆ.

Genus **Gobius**, Artedi.

Gobius Friesii, Malm. (Littoral.)

(Pl. XLI., fig. 3.)

Gobius Friesii, ...	MALM, "Forh. ii. Naturf. Mode.," 1873, p. 583.
,, ,, ...	COLLETT, "Forh. vidensk. Selsk. Chra. aar. 1874.," 1875, p. 154.
,, ,, ...	HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., 1892, p. 220.
,, ,, ...	SMITT, "Hist. Skand. Fish.," ed. ii., 1893, p. 248.
,, *gracilis*, ...	FRIES, "Vet. Akad. Handl.," 1838, p. 245.
,, ,, ...	NILSS., "Skand. Faun.," iv., 1855, p. 224.
,, *macrolepis*, ...	SCHARFF, "Proc. Roy. Ir. Acad.," 3rd S., i., 1891, p. 458.

DIAGNOSIS OF SPECIES (Di. 6; Dii. 14–15; A. 13–15; L. lat. 25).—Body rather compressed, length of the head about 3⅔ times in the total length, without the caudal. Eye nearly one-third of the length of the head, and equal to or slightly exceeding the length of the snout. Large imbricating scales on the top of the head behind the eyes, and in regular rows on the body. Throat naked in young, clothed with small imbricating scales in old examples.

Jaws with several series of small closely set teeth, those of the outer series (of the lower, frequently of both jaws) less numerous, larger than the rest, and unciform.

Anterior ray of the first dorsal may be produced into a filament (in males?). Second dorsal and anal fin rather high, the posterior rays nearly twice as long as the anterior, and, except in young examples, extending as far as, or a little beyond, the origin of the caudal, which is large and somewhat lanceolate. The anal papilla conical.

Several conspicuous horizontal rows of dermal papillæ on the anterior part of the gill-cover. Colour brown or yellowish, with rows of darker brown or golden-yellow spots along the dorsum and the lateral line. Throat and fin-membranes with numerous minute dark specks.

The above diagnosis is formulated on the lines of the description given by Collett (*l. c.*), but certain alterations have been made in accordance with the fresh light afforded by the material collected during the survey, and by the single

specimen taken by the "Flying Falcon." According to Collett's experience only the lower jaw exhibits an outer series of larger teeth, but we find such a series present in both jaws, the teeth, moreover, being distinctly unciform in character in the larger of the Irish examples. Of the alternative colourations we have mentioned, the more brilliant appears to have been observed only by Fries, the discoverer of the species. The specimen which he obtained was stale, and he considered that it must have been more brilliantly coloured in life. No notes were taken of the Irish examples at the time of capture, but the recollection of one of us is sufficiently clear to enable us to affirm that the general colour was a dull brown, the spots being darker. Collett's experience appears to have been to the same effect.

To Dr. Scharff belongs the credit of first recognising the species as one new to the British Fauna, but it was his misfortune to obtain only a single half-grown example, which, from the very scanty information at that time available, could not with certainty be referred to *G. Friesii* or to any other form. It was accordingly described as a new species under the name of *G. macrolepis* (Scharff, *loc. cit.*).

While the Survey Collections were being sorted, the attention of one of us was drawn by Dr. Scharff to the great resemblance which several gobies, trawled in Killybegs Harbour and Cleggan Bay, bore to his type of *G. macrolepis*. The resemblance between the last named and *G. Friesii* (Malm.) had been already noted by the discoverer of the former, and he was kind enough to give us references to the literature of the species. On examining our material it became apparent that while all the Survey examples were certainly of the same species, the larger agreed best with *G. Friesii* and the smaller with *G. macrolepis*. In order to decide the question, all Irish specimens, including that taken by the "Flying Falcon," were, with Dr. Scharff's consent, submitted to the examination of Herr Collett, who, after comparing them with an undoubted example of *G. Friesii*, arrived at the conclusion that they belonged to that species. It is therefore placed beyond dispute that the differences between *G. macrolepis* and *G. Friesii* are merely developmental, and not of specific importance. The type of *G. macrolepis* measures only 7·8 cm., and is of nearly the same size as the smallest Survey example of *G. Friesii*, the specimen figured by us (Pl. XLI., fig. 3) is represented of the natural size, *i.e.* 8·8 cm., and Collett speaks of an example of 10 cm. The developmental changes which take place within such an interval of growth, as indicated by the differences in the diagnosis of *G. macrolepis* and *G. Friesii*, and illustrated by the Survey series, are chiefly as follows.—The eye becomes, as usual, relatively smaller, and the head relatively shorter as the size increases. The eyes which, in a specimen of 7·8 cm., are separated by an interval equal to one-fifth of their diameter, become so closely apposed in specimens of about 9 cm. that there is

hardly any interspace left. The throat, scaleless in the smaller examples, is clothed with minute imbricating scales in the larger ones. The height of the second dorsal and anal undergoes a relative increase, so that, whereas in young examples the extremities of the posterior rays of even the dorsal scarcely reach the origin of the caudal, in full-grown examples the posterior rays of both second dorsal and anal extend considerably beyond that point, even when erected to what appears to be the most vertical position attainable (*cf.* fig. 3). The elongation of the anterior ray of the first dorsal is a character which seems to have escaped the notice of Scandinavian writers, which is the less remarkable in that there is no constancy in its occurrence. It may, in fact, be indifferently present or absent in examples of any size with which we are acquainted. In the specimen figured the extreme point of the ray is wanting, but it does not appear probable that its original length was ever greatly in excess of that shown in the drawing. On the other hand several of our larger specimens show the ray prolonged in exactly the same way as in Scharff's figure of *G. macrolepis*. The character may be sexual, but this we are unable to affirm. It may be noted that Scharff's specimen was a mature male.

The variation in the fin-ray formula of the species does not appear to be extensive. The information at our disposal is as follows:—

Di.	6	Dii.	14	A. 14	Type specimen (Fries).
	6		15	13	Specimen of 5·9 cm. (Collett).
	6		15	15	Type of *G. macrolepis* (Scharff).
	6		15	14	Four examples from the Survey Collection.
	6		15	14	
	6		15	(?)	
	6		14	13	

We are not disposed to regard the large number of anal rays in *G. macrolepis* as of sufficient importance to interfere with the association of the two species.

Locality and Distribution.—Previous to its discovery in Ireland, *G. Friesii* was only known from three specimens, from the Strömstad and Gullmar Fjords in Sweden, and Christiania Fjord in Norway. Scharff's specimen was taken at 5 fathoms on the S.W. coast of Ireland,* while those collected during the Survey occurred in the outer harbour, Killybegs, and in Inver and Cleggan Bays, the depths ranging from 1 to 10 fathoms. In the first two of these localities the fish is probably far from rare, as several were obtained in a single haul. Smitt, who has overlooked the Irish records, considers that it is a deep-sea species, but we know of no reason for this opinion.

* Mr. A. R. C. Newburgh informs us that he has also taken the species on the S. W. coast since the Survey was completed.

Gobius Jeffreysii, Günther. (Deep-sea.)

Gobius Jeffreysii,	. . . .	GÜNTHER, "Ann. Mag. Nat. Hist.," 1867, xx., p. 290, and 1874, xiii., p. 138.
,,	,, ...	GÜNTHER, "Proc. Roy. Soc. Edin.," 1888, xvi., p. 120.
,,	,, ...	COLLETT, "Norg. Fisk," p. 54.
,,	,, ...	LILLJEBORG, "Sverig. o. Norg. Fisk," i., p. 587.
,,	,, ...	SMITT, "Hist. Skand. Fish," Ed. ii., p. 261.
,,	*quadrimaculatus*, . .	DAY, "Fish. Gt. Brit.," i., p. 168.

Two adult examples of this species, now for the first time recorded from Irish waters, were taken during the survey. Of these the larger, measuring 3·1 cm. was taken in Dingle Bay. The other appears by the label to have come from Kilkieran Bay, Aran Islands, Co. Galway, but we have reason to believe that the label has been accidentally changed and that the specimen was really taken off Balycottin in 41 fathoms. A large number of small gobies, which appear also to belong to this species, were trawled in August, 1890, off the Skelligs in 80 fathoms, and also off Balycottin.

The species was first taken by Jeffreys off the Hebrides, in 1867, at 80 to 90 fathoms, and was subsequently found by Wyville Thompson, at 180 fathoms in the Faroë Channel. More recently ten examples were captured by Murray in the Clyde estuary. Among these were a male and female engaged in spawning at the time of capture, which enabled Dr. Günther, who has recorded these and the previous specimens, to point out the striking differences of colour which then occur.

The female was marked and coloured in the ordinary manner, but the male, which was only one and a-half inches long had a uniformly coloured body, without spots, with fins showing most beautiful ornamentation. A figure of the breeding male accompanies Günther's description,* while the ordinary colouration is shown in his figure of the type.† The figure given by Day is either that of Günther's type or of a specimen taken at the same time.

The species has been recorded also from Norway: from the deep-water of Stavanger Fjord by Sars, and from Haagesund by Lilljeborg. The two adult examples taken during the Surrey have the ordinary colouration, but the smaller ones, perhaps two small for exact specific determination, in many cases, are almost wholly destitute of dark pigment of any description.

* "Proc. Roy. Soc. Edinb.," *tom. cit.*, pl. iii., fig. B.

† "Ann. Mag. Nat. Hist.," 1867, xx., pl. v., fig. C.

Genus **Aphia**, Risso.

Aphia pellucida, Nardo. (Littoral.)

Gobius pellucidus, ...	NARDO, "Giorn. Fis. Chirn. Stor. Nat. Pavia," 1824, iii., p. 7.
Latrunculus pellucidus, . .	GÜNTHER, "Cat. Fish. Brit. Mus.," iii., p. 556.
,, ,, . . .	COLLETT, "Proc. Zool. Soc. Lond.," 1878, p. 319.
Aphia pellucida, ...	DAY, "Fish. Gt. Brit.," i., p. 169.
,, ,, ...	HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 169 and 432.
Atherina minuta, ...	RISSO, "Ichth. Nice.," p. 340.
Aphia meridionalis, . . .	RISSO, "Fauna Eur. Merid.," iii., p. 287.
Gobius albus, ...	PARNELL, "Trans. Roy. Soc.," Edinb., xiv., p. 137.
,, *Stuwitzii*, ...	DÜBEN and KOREN, "Kgl. Vet. Akad. Förhundl.," 1844, p. 51.
Slender Goby, ...	COUCH, "Brit. Fish.," ii., p. 172.
Transparent Goby, ...	COUCH, "Brit. Fish.," p. 171.

To Collett belongs the credit of clearing up the synonomy of this remarkable form in showing that the *Gobius albus* of Parnell, and the *Gobius Stuwitzii* of Düben and Koren were but male and female of the same species; and further, in showing that the original *Gobius pellucidus* of Nardo was identical with *Gobius Stuwitzii.*

The Scandinavian author was further able (*loc. cit.*), by his exhaustive observations of the life-history, to give a most detailed description of the fish at all stages, and to reconcile the discrepancies in the descriptions of previous authors by demonstrating that such are due, especially as regards the teeth, to developmental changes and sexual dimorphism. In the nearly mature males we find, for instance, that "besides the minute teeth, there is become visible an outer row of cylindrical teeth, yet not full-grown, but having reached a greater length than the others," whereas in fully mature fish of the same sex we are told that, the minute teeth having disappeared, those that remain are "of only one kind, few in number, but long and cylindrical." The females retain throughout life the dentition characteristic of the younger stages of either sex, or, in other words, exhibit the features of *G. Stuwitzii.*

The largest male observed by Collett measured 43 mm., while no female exceeded a length of 46 mm., and the author is inclined to believe that the species is an annual vertebrate, dying at the end of the first spawning period. The survey

examples are four in number, two males and two females, all adult, and with reproductive organs fully matured. They were taken in Killybegs Harbour, on the 23rd June, 1890, and, although the same ground was carefully worked over the following year, no further examples could be met with. The largest, a male, considerably exceeds the greatest measurement given by Collett or by Day, and appears to be of unusual size. It measures 55 mm. or $2\frac{5}{32}$ inches.

The species is known from several localities in Norway; along the Western coast of Continental Europe; and from the Mediterranean and Black Sea, in the British Isles from Solway Firth, Frith of Forth, Aberdeen, Weymouth, south and south-west coast, and Bristol Channel. The four Survey examples are the only ones recorded from Ireland.

Genus **Crystallogobius**, Gill.

Crystallogobius Nilssonii, Düben and Koren. (Littoral.)

Gobius Nilssonii, ...	Düben and Koren, "Kgl. Vit. Akad. Forhandl., Stockh.," 1844, p. 53.
Gobiosoma Nilssonii, . . .	Günther, "Cat. Fish. Brit. Mus.," iii., p. 86.
Crystallogobius Nilssonii, . .	Gill, "Proc. Acad. Nat. Sci. Phil.," 1863, p. 269.
,, ,, ...	Collett, "Proc. Zool. Soc. Lond.," 1878, p. 331.
,, ,, ...	Day, "Fish. Gt. Brit.," i., p. 172.
,, ,, ...	Holt, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 121, 218, 432.
Gobius linearis, ...	Düben and Koren, "Ofver. Vet. Akad. Handl.," 1845, i. p. 111.

The species has been well described by Collett (*loc. cit.*).

Like the last, it has received such ample attention at the hands of Collett that reference to it, except as regards the distribution, is unnecessary. Previous to the Survey we believe that only two specimens had been recognised from British waters, viz. one taken by Thomas Edwards in a rock pool at Banff,* in 1868, and another recorded in the Naturalists' column of the *Field* probably by Dr. Day.

During the cruise of the "Fingal" a great number were taken in Ballinskelligs Bay, while others were found in the stomachs of larger fish in Galway Bay. In the following year the use of suitable nets demonstrated that the species occurred in abundance along practically the whole of the western coast, at depths from 10 to 41 fathoms, the additional localities being the Kenmare River†,

* Smiles, "Life of a Scotch Naturalist," pp. 375 to 427.

† It should be remembered that this so-called river is really an arm of the sea, and not an estuary

Ballynakill Bay, Davalann, Clew Bay, Broadhaven Bay, Killybegs outer harbour, and Sheephaven. Shortly after the capture of the "Fingal," specimens had been announced by one of us. The occurrence of the species in large numbers off the Eddystone Lighthouse was recorded by Cunningham, who conjectured (*loc. cit.*) that it was "fairly abundant between 20 and 30 fathoms, on smooth sandy ground, all along the British and Irish coasts." The surmise, in addition to the confirmation it had already received by the (then unpublished) results of the "Harlequin" investigations, has since been borne out by the experience of one of us in the North Sea, where *C. Nilssonii* has been taken off Flamborough Head; while fragments which almost certainly belong to the same species have been seen adhering to the trawls of vessels returning from other grounds. It may be noted, as shown by the results of the Survey, that the vertical range is rather more extensive than was supposed by Mr. Cunningham, while the fish occurs on muddy as well as on sandy ground.

It is known to occur on the Scandinavian coast as far North as Christiansund, but does not appear to have been recognised in any other locality except those already mentioned. Day, in the light of the information at his disposal, considered it to be evidently much rarer than *Aphia pellucida*, and partial to more northern localities. It is certainly infinitely more numerous than Aphia on British coasts; and it seems very probable that the limited extent of its known horizontal range is in great part due to the ease with which it may be mistaken for the young condition of some larger fish.

It does not appear that *C. Nilssonii* has ever been utilised as human food, although, like the preceding species, it might probably be procured in sufficient quantities to serve as "white bait." Its importance as food for other fishes was adverted to some years ago, by a writer in the *Field* newspaper, and is sufficiently emphasised by the frequency with which the species figures in the list of organisms taken from the stomachs of larger forms during the Survey.*

Genus **Callionymus**, Linnæus.

Callionymus lyra, Linnæus. The Dragonet. (Deep-sea.)

Callionymus lyra, ... VAILLANT, "Exp. Sci. Trav. Talism. Poiss.," p. 349.
" " . . . . SMITT, "Hist. Skand. Fish.," ed. ii. p. 273.

The species appears to be common along the west coast of Ireland. It was not met with at more than 62 fathoms, and has never been recorded from below the 100-fathom line in British waters. Vaillant, however, found it at 130 fathoms off

* *Cf.* Holt, "On the Food of Fishes on the West Coast."—Sci. Proc., iv., pp. 457–471.

the coast of Portugal, and at 218 fathoms in the Bay of Biscay; while Smitt mentions an example in the Royal Museum of Norway, said to have been taken at 100 to 200 fathoms, off the Jutland Reef. It is, therefore, in accordance with the plan of this Paper, placed amongst the deep-sea fishes; whereas *C. maculatus*, though not improbably more bathybial in its general distribution on our own coasts, has to be relegated to the littoral species; a circumstance which sufficiently illustrates the difficulty of drawing a hard-and-fast distinction between the two classes.

It is noted by Dr. Günther* that the mature male is not found in such shallow water as the female or young; and our own experience supports the general accuracy of this statement. We have, however, received a fully mature male from Tetney, a part of the Humber estuary where the depth is, at the most, five fathoms. Day† states that the fish "does not appear to congregate in shoals," a remark which applies, if at all, only to the adults, since great numbers of young and half-grown examples were taken during the Survey in Inishbofin Harbour, while about 100 have frequently been taken by one of us in a single haul of the shrimp-trawl on the Humber ground already referred to.

The synonymy of the species is now so generally understood that it is unnecessary for us to make more than a passing allusion to the fact that the female and young were long regarded as distinct;‡ and it appears to us that such descriptive observations as we have to make may be most conveniently reserved for comparison with the next species.

* "Cat. Fish. Brit. Mus." iii. p. 369. † "Fish. Gt. Brit." i. p. 176.

‡ Male, ... *C. lyra*. Linn., "Syst. Nat." i. p. 433, *et auct. plur.*
,, ... *Uranoscopus lyra*. Gronov. ed. Gray, p. 42.
Female and young, . *C. dracunculus*. Linn., *loc. cit.*, *et auct. plur.*
,, ,, . . *U. dracunculus*. Gronov. ed. Gray, *loc. cit.*
Young (?), ... *C. elegans*. Lesueur, "Bull. Soc. Phil. Paris," 1814, p. 6.
Young male, . . . *U. micropterygius*. Gronov. ed. Gray, *loc. cit.*

Callionymus maculatus, Bonaparte. (Littoral.)

Callionymus maculatus,	. .	BONAPARTE, "Faun. Ital. Pesc.," figs. 2 and 3.
,,	,, . . .	GÜNTHER, "Ann. Mag. Nat. Hist.," 1867, vol. xx., p. 290.
,,	,, . . .	DAY, "Fish. Gt. Brit.," vol. i., p. 177.
,,	,, . . .	LILLEJBORG, "Sverig. o. Norg. Fisk," p. 666.
,,	,, . . .	GÜNTHER, "P. R. S. Edinb.," xv., p. 211.
,,	,, . . .	HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., p. 218.
,,	,, . . .	SMITT, "Hist. Skand. Fish.," ed. 2, p. 279.
,,	*lyra*, . . .	RISSO, "Ich. Nice," p. 113.
,,	*dracunculus*, . .	BRÜNNER, "Pisc. Mass.," p. 17.
,,	,, . . .	CUVIER, "Règne Anim."
,,	*cithara*, . . .	CUVIER et VALENCIENNES, "Hist. Nat. Poiss.," vol. xii., p. 280.
,,	*reticulatus*, . .	CUVIER et VALENCIENNES, "Hist. Nat. Poiss.," vol. xii., p. 284.

DIAGNOSIS OF SPECIES.—The horizontal diameter of the eye rather longer in the male, rather shorter in the female, than the length of the snout, without the protrusible mouth.

This appears to be the most salient character distinguishing this from the commoner species, *C. lyra*, in which the length of the snout considerably exceeds the horizontal diameter of the eye in both sexes, except in the very youngest stages.

So closely allied are the two forms that it seems to us that any useful description of the one must contain frequent comparison with the other. Moreover, in both, the male differs so much from the female that it is necessary to describe the sexes separately, and though this has been excellently done by Lilljeborg, British authors have hitherto contented themselves with pointing out the difference in the length of the first dorsal fin and in the colouration. These features, however, are only apparent in adults; and a description of the pigmentation is chiefly valuable to those who have the opportunity of observing specimens in the fresh condition.

The two species differ considerably in size, the commoner, *C. lyra*, attaining a length of about twelve inches, whilst *C. maculatus* appears never to greatly exceed a length of six inches. Hence it follows that the more conspicuous features of sexual dimorphism are attained at different sizes, so that a male of the smaller form exhibits the full adult characters at a size at which one of the larger is still in

that respect immature. We are not in a position to affirm any exact size at which the elongation of the dorsal commences in either species, and, no doubt, in this respect there is considerable variation; but amongst the examples before us a male of *C. maculatus* is fully mature at 4⅛ inches, whereas the smallest male of *C. lyra* which exhibits any (external) approach to maturity is 4⅞ inches long. There is thus a possibility, in so far as concerns the elongation of the dorsal, of confusion between a mature female of *C. maculatus* and an immature male of *C. lyra*, to avoid which, in the absence of any very well-marked differences in colouration, a somewhat close inspection of minor characters is necessary, and we believe that the subjoined Table of dimensions and remarks will be found of use.

C. maculatus. (Adult.)

Male.		Female.	
Length of head to total length without caudal fin,	1 to 3¾	Length of head to total length without caudal fin,	1 to 3½
Horizontal diameter of eye to length of head,	1 to 3½	Horizontal diameter of eye to length of head,	1 to 2½
Length of snout (exclusive of protractile mouth) to horizontal diameter of eye,	1¼ to 1	Length of snout (exclusive of protractile mouth) to horizontal diameter of eye,	1 to 1⅛
Width of interorbital space to horizontal diameter of eye,	1 to 5 *ca.*	Width of interorbital space to horizontal diameter of eye,	1 to 6 *ca.*
Anterior dorsal ray elongated, reaching the middle of second dorsal.		Anterior dorsal ray not elongated.	

The second dorsal fin of the adult male is considerably higher in *C. maculatus* than in *C. lyra*. In a specimen of the former, 4⅛ inches long, the first ray of the fin mentioned is contained not quite 3 times in the total length, without the caudal. In three specimens of *C. lyra*, exhibiting the full development of the first dorsal, and measuring respectively 4⅞, 7½, and 9 inches, the same ray is contained 5¾, 5, and 6 times in the total, without the caudal. In males of both species, according to Lilljeborg's description and our own experience, the second dorsal fin is highest posteriorly, although Day's figure of the male *C. maculatus* shows this fin highest in front. It is of about equal height throughout in females of both species. The first ray of the first dorsal in fully adult males of *C. lyra* extends back as far as the caudal, but of course intermediate stages occur, necessitating a recourse to other characters for specific determination. Such are furnished by the proportions of the eye and snout, which differ considerably in the two species, since in the adult male *C. lyra* the horizontal diameter of the eye is contained 2½, in the adult female 1¼ times in the length of the snout (exclusive of the protractile mouth

apparatus). It is thus comparatively easy to distinguish the two species if examples of the same sex are compared, but the difference between a mature male of the smaller and an immature female of the larger species is not very conspicuous so far as these proportions are concerned. In this case, however, the characters of the dorsal fin will serve to obviate any confusion.

Since the proportions of the eye vary to some extent with the growth of the fish it may be supposed that those which we have given above as characteristic of the adult stages of *C. lyra* may not be available in distinguishing young examples of this species from specimens of *C. maculatus* of an equal size. As a matter of fact, however, there is little risk of confusion, as we may illustrate by comparing a mature female *C. maculatus* with the female *C. lyra* which, in our collection, presents the nearest approach to it in size. The former measures 6·1 cm., and the latter 5·4 cm. (the caudal being excluded in both cases). As the proportion of the eye varies in inverse ratio with the size of the individual, it is obvious that the contrast will be less marked (the smaller specimen belonging to the species characterised by the smaller eye) than if the two were of the same size. Still in *C. maculatus* we find the eye ·6 cm. and the snout (without the protractile mouth apparatus) only ·4 cm., whereas in *C. lyra* the dimensions are respectively ·50 and ·55 cm. Thus in *C. maculatus* the eye is half as long again as the snout, which in the other species exceeds the eye by one-tenth. Moreover, the distance between the tip of the mandible and the vent is contained $2\frac{1}{7}$ times in the total without the caudal in *C. maculatus*, in *C. lyra* only 2 times. The caudal region is much thicker in the former, and the eyes much closer together; and although such actual approximation seems to some extent a feature of individual variation, the width of the interorbital space relatively to the length of the eye is always much less in *C. maculatus* than in *C. lyra*.

We note further that in a large series of *C. lyra*, of about the same size as, or a little smaller than, the one we have been dealing with, the opercular trident is constantly masked with skin except at the extremities of the denticles. In the adults of *C. maculatus*, corresponding in size to these last, the trident is entirely naked. The state of the specimens shows that this is natural, but a similar condition might so easily manifest itself in abraded examples of *C. lyra* that little weight should be attached to the character in cases of doubtful identity.

The brilliant colouration of the adult male of *C. lyra* is closely imitated, so far as general tints are concerned, by the adult male of the smaller species. The latter, however, is readily distinguished by the markings of the second dorsal fin alone. On this fin there are four longitudinal rows of conspicuous dark spots, crossed by a number of vertical rows of light markings, each with a narrow, dark outline. The same fin in *C. lyra* merely exhibits four indistinct, dark, longitudinal bands. The female of *C. maculatus* has the second dorsal profusely speckled with dark

markings, a condition not observable at any stage of either sex of the larger species. The body markings of adult males fade rapidly in alcohol, but those of the fins remain recognisable for a considerable time.

The sexual differences of proportion tend to disappear as the size diminishes, but the specific characters of the eye and snout are available for diagnosis from a very early age, the snout being longer than the eye in specimens of *C. lyra*, not more than an inch long. In colour, young examples usually resemble the adult female; but we have seen specimens of *C. lyra*, from 3 to 4 inches long, which were brilliantly marked with green purple and crimson. These were taken from a ground in the Humber estuary; and, from the colouration of flat fish on the same ground, we conclude that the markings were explicable by the nature of the bottom: in any case they were in no way sexual.

The fin-ray formula is of no assistance in distinguishing the two species, as may be seen from the subjoined enumeration.

C. maculatus.

Di. 4. Dii. 9–10. A. 8–9. Pelv. $\frac{1}{5}$.

C. lyra.

Di. 4. Dii. 9. A. 9. Pelv. $\frac{1}{5}$.

In speaking above of "mature" and "immature" examples we have used the terms only in reference to the external characters. We are unable to say, from our own knowledge, that these features of sexual dimorphism are, or are not, habitually assumed, *pari passu*, with sexual maturity; but it appears from an observation of Dr. G. Johnston,* that the male may be sexually mature before the fin becomes elongated. It is noteworthy that in *Arnoglossus laterna*, a species in which (if we are right in supporting Cunningham's contention of the identity of *A. laterna* and *A. lophotes*) the dimorphism affects the same structures as in Callionymus, sexual maturity is attained (commonly, if not universally) long before the dimorphism is apparent.

Locality and Distribution.—Previous to the Survey, *C. maculatus* had not been recorded from Irish waters. It was first established as British by Dr. Günther,† three specimens having been obtained in the Hebrides from depths of 80–90 fathoms. Since then several have been taken by Dr. John Murray in 26 fathoms in the Clyde Estuary,‡ the largest measuring four and a-half inches. Of our own

* Zool. Journal, iii., p. 366. The observations refer to *C. lyra*.

† Günther, Ann. Mag. Nat. Hist., 1867, xx., p. 290.

‡ Günther, Proc. Roy. Soc. Edin., 1888, xv., p. 211.

examples, a mature male and female came from 38 fathoms, off Gregory Sound; a mature female from 41 fathoms, off Valentia; and a mature male most probably from 30 to 19 fathoms in Donegal Bay, the label, unfortunately, being in this case wanting. Two small examples, from 41 fathoms off Valentia, and 80 fathoms off the Skelligs, prove, on re-examination, to belong also to this species.* *C. maculatus* has been met with also in Norwegian waters, and off the coast of Denmark, while it is common in the Mediterranean. It seems probable that, in northern latitudes, it occasionally passes the 100-fathoms line, but we are acquainted with no record to that effect.

Fam.—GADIDÆ.

Genus **Gadus**, Artedi.

Gadus morrhua, Linnæus. The Cod. (Deep-sea.)

During the survey this species was only met with in shallow water or at moderate depths, but it is known to descend beyond the 100-fathoms line on the coast of Norway.† Günther (Chall. xxii., p. 82) remarks that cod-fish retire during the summer months into deeper water; but, according to our information, it appears that they are abundant all the year round off the Faroë Islands at depths exceeding 100 fathoms.

Gadus æglefinus, Linnæus. The Haddock. (Deep-sea.)

As already recorded by one of us,‡ haddocks were taken both in the trawl and on the long lines at 154 fathoms, 28 miles off Achill Head, on the 20th April, 1891. So far as we are aware this is the only exact record of the occurrence of the species in deep water, but we believe that it is commonly taken at considerable depths off the Faroë Islands.

Gadus merlangus, Linnæus. The Whiting. (Littoral.)

Among the whiting taken during the Survey was a fully adult specimen having a distinct, though small, barbel. The presence of this appendage in very young specimens has been frequently referred to by authors. The condition of the adult under consideration shows that the absence of the barbel cannot be insisted upon as invariable.

* They were previously recorded by one of us as *C. lyra*, Sci. Proc. Roy. Dubl. Soc., p. 433.

† Lilljeborg, "Sverig. o. Norg. Fisk," p. 31.

‡ Holt, "Sci. Proc. Roy. Dubl. Soc.," vii., pp. 219, 272, 273.

Sub-genus **Boreogadus**, Günther.

Gadus poutassou, Risso. The Poutassou. (Deep-sea.)

On the 10th July, 1890, while the trawl of the S.S. "Fingal" was down at 175 fathoms, thirty-four miles off Achill Head, a large shoal of young Poutassou was observed at the surface. They were darting violently about, and a number were easily captured in a large tow-net. According to the mate, who was the first to observe them, they were being chased by a large squid, which, however, had disappeared by the time the attention of Mr. Green and Professor Haddon had been called to them. The fish captured were carefully examined by one of us a few minutes afterwards, but they presented no sign, by distension of the air-bladder or otherwise, of having been driven upwards from any considerable depth. It may therefore be supposed that, previous to their disturbance, the fish were swimming at or near the surface. The stomachs were full of small crustaceans, copepods, etc. In the fresh condition the dorsum was a dark greenish grey, the sides silvery.

All the specimens taken were much alike in size, the total length ranging from $5\frac{1}{2}$ to 6 inches. Day* figures a specimen about an inch longer, but the most satisfactory figure with which we are acquainted is that given by Vinciguerra.†

The poutassou, first recorded from the Mediterranean, where it appears to inhabit considerable depths, is said to occur not infrequently on the Scandinavian coast, in the proximity of the 100-fathoms line (Collett and Lilljeborg). Though comparatively little known as a British form, it has nevertheless been already reported from the coast of Ireland (Macandrew and W. Andrews). It has also been found off North Uist (M'Intosh), in the Hebrides, and on several occasions large shoals, consisting apparently of young fish only,‡ have been observed on the south-west coast of England, though there is no evidence that the species is permanently resident in that locality. Thus, while, as Günther remarks,§ the fish habitually lives in somewhat deeper water than its congeners, it seems probable that in its immature condition it is to a great extent pelagic and migratory.

* "Fish. Gt. Brit.," pl. lxxxiii. † "Ann. Mus. Genov.," xviii., p. 550.

‡ *Cf.* Couch, "Brit. Fish.," iii., p. 77, and Day, "Fish. Gt. Brit.," i., p. 293 (quotes Dunn of Mevagissy).

§ "Chall.," xxiii., p. 82.

Gadus Esmarkii, NILSSON. The Norway Pout. (Deep-sea.)

Gadus minutus, ...	ESMARK, "Forh. Nat. Möti i Christ.," 1844, p. 231.
Gadus Esmarkii, ...	NILSSON, "Skand. Fauna," iv., p. 565.
,, ,, ...	GÜNTHER, "Cat. Fish. Brit. Mus.," iv., p. 337.
,, ,, ...	SMITT, "Hist. Skand. Fisk," ed. 2, p. 508.
,, ,, ...	HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 122, 219, 438.

DIAGNOSIS OF SPECIES.* (Di. 14–16; Dii. 22–26; Diii. 22–27. Ai. 26–30. Aii. 23–28).—Lower jaw projecting beyond the upper; teeth of the outer series of the upper jaw a little larger than the inner ones. The length of the head contained about four times in the total length, without the caudal, and greater than the height of the body, which is about two-ninths of the same dimensions. The length of the eye about one-third of the length of the head, and equal, or nearly equal to the length of the snout. The height of the caudal peduncle less than the vertical diameter of the eye, which is about one-third greater than the width of the interorbital space: the latter with a median groove. Dorsal fins separated by narrow interspaces, the greatest height of the body opposite the first; the anus at, or near, a vertical line passing between the first and second dorsals. The two outer pelvic rays produced to filaments, of which the longer may extend as far back as the anus. Barbel slender, not more than half the length of the eye. Scales small, imbricating; lateral line with a gentle curve in its anterior region.

Colours.—Greyish brown on the dorsum, dull silvery on the sides, pale on the ventral abdominal region.

The occurrence of this species in British waters was first noted by Günther in 1888.† In the descriptive remarks appended to his record, the author notes certain differences which occur between the specimens under his consideration (from the west coast of Scotland), and some larger specimens in the British Museum, communicated by Collett from Norway. Notably he finds that the Scotch specimens are stouter in general form, and that the eye in the Norwegian specimens is considerably larger in proportion to the size of the head.

The material in the Survey collections comprises twelve examples, which vary considerably, not only in size but in proportion; and it is important to notice that while some partake of the stout character of the Scottish forms, others agree much

* An excellent figure is given by Dr. Günther, Proc. Roy. Soc. Edinb., xv., 1888, Pl. iii. A.

† "Proc. R. S. E.," *loc. cit.*

more with the Scandinavian. The relation of height to length of body may be taken as an instance. In a specimen nearly 4 inches (10 c.m.) in total length, taken off the Galway Aran Islands, the length, exclusive of the caudal fin, is $4\frac{1}{2}$ times the height, whereas in one of $6\frac{5}{16}$ inches (16 c.m.), taken off the Kenmare River, the length is $5\frac{3}{4}$ times the height. The largest example of the series, however, a fine specimen of $7\frac{1}{2}$ inches (19 cm.), taken at 144 fathoms, 15 mi., north-west of Achill Head, agrees in this respect with the specimen of 10 cm., and therefore with the Scottish forms studied by Dr. Günther. On the other hand, in the proportions of the eye and head, the example of $7\frac{1}{2}$ inches, distinctly resembles the Norwegian condition, since the eye is one-third of the length of the head, and equal in length to the preorbital region, when the mouth is closed. The barbel is less than half the length of the eye.

The smaller Irish specimens agree with those from Scotch waters in the comparatively small size of the eye, and, since the dimensions of that organ, in the development of an individual, varies in inverse ratio with the total length, it must be taken that the difference is indicative of a variation of proportion, and not of developmental change. The resemblances, nevertheless, appear to us so much more striking than the discrepancies, that we have no hesitation in adopting Dr. Günther's conclusion that they are not of specific value. Moreover, although by taking the *greatest* height of the body as a standard, our largest example appears identical in proportions with the smaller, the general appearance is decidedly more slender. The smaller specimens resemble *G. minutus* rather closely, and might readily be mistaken for examples of that species; but the larger have distinctly assumed the elongate form characteristic of all members of the sub-genus Boreogadus, and exemplified, among the forms under consideration in this paper, by *G. poutassou*. The latter, however, is distinguished at a glance from the species before us by the greater interspace between the second and third dorsals, as well as by other characters hardly less striking.

In both *G. Esmarkii* and *G. argenteus*, the caudal peduncle is more slender than in most Gadi which inhabit chiefly the more littoral regions. This slenderness is of interest, since it may possibly indicate a progression towards the typical condition of so many genera of deep-sea Gadoids, where the caudal region tapers away to a point, and bears no true caudal fin.

The Irish examples yield the following fin-ray formula:—D. 14–16, 23–25, 22–23; A. 26–29, 23–25; but, in enumerating the formula in our diagnosis, we have made use of all available information on the subject. It appears that such variation as exists is not of local importance, since the maximum and minimum number of rays have been observed, respectively, in Scandinavian specimens by Smitt and Lilljeborg.

The body cavity is lined with a dense black peritoneum, and extends to a

point somewhat behind the middle of the first anal fin. In our largest example, a female taken in July, the left lobe of the liver is enormously developed, and occupies the whole of the left side of the cavity. The ovaries, in this example, are of comparatively small size, spawning having been probably accomplished some considerable time previous to capture. It has already been noted by one of us * that the female is mature at a length of about 4 inches, and it is possible that maturity may be attained at even asmaller size, since Günther speaks of the Scotch specimens, which were from $3\frac{1}{2}$ to 7 inches long, as having the ovaries much expanded. The ova, and probable larva, have already been described in these Transactions.† The maximum size reached by the species is uncertain, but it is evidently not considerable. The largest specimen observed by Collett measured $9\frac{1}{2}$ inches (24 cm.).

Locality and Distribution.—The Norway Pout appears to be entirely confined to the waters of Northern Europe. On the coast of Scandinavia it appears to be fairly plentiful, but local; the recorded localities, according to Smitt, being the Christiania, Trondhjem, Strömstad, Dynehil, and Säche fjords. Lütken has reported it from the Faroë Islands. On the west coast of Scotland it was recognised by Günther in the collections made by Mr. Murray from Kilbrennan Sound, Sanda, Lower Loch Fyne, the Sound of Mull, the Mull of Cantyre, Upper Loch Nevis, Loch Sunart, and Loch Aber. During the Survey a number were taken,‡ either in the nets or from the stomachs of larger fish, off the Kenmare River, the Aran Islands, Clare Island, and Achill Head.

The species is met with in Norway in deep water, but there appears to be no exact record of the depth. The Scotch examples were taken between 26 and 80 fathoms, and the Irish between 38 and 50, with the exception of one, trawled at 144 fathoms. It had not previously been observed in Irish waters, nor exactly recorded from below the 100-fathom line. Subsequent to the Survey, the species has been reported by one of us from the Great Fisher Bank in the North Sea.

Sub-genus **Gadiculus.**

Jaws sub-equal, cleft of the mouth highly oblique; head, in adult, deeply sculptured with muciferous cavities; a scaleless fossa on the nape; scales rather large, deciduous. Teeth small, in a narrow band; vomerine teeth present only in young examples.

* "Sci. Proc.," vii., p. 399. † S. iii., v., p. 54. ‡ *Cf.* "Sci. Proc.," vii., p. 438.

Gadus argenteus, Guichenot. The Silvery Pout. (Deep-sea.)

(Pl. XLI., figs. 1 and 1*a*.)

Gadiculus argenteus, . . .	GUICHENOT, "Explor. Algér. Poiss.," p. 102.
,, ,, ...	GÜNTHER, "Cat. Fish. Brit. Mus.," viii., p. 341.
Gadus argenteus, ...	GÜNTHER, "Ann. Mag. Nat. Hist.," 1874, p. 138.
,, ,, ...	DAY, "Zoologist," vol. xliii., p. 312.
,, ,, ...	BOURNE, "Jour. M. B. A." (N. S.), vol. i., p. 310.
,, ,, ...	HOLT, "Sci. Proc. Roy. Dub. Soc.," vol. vii., p. 122.
Merlangus argenteus, . . .	VAILLANT, "Exp. Sci. Trav. Talism. Poiss.," p. 302.

Guichenot's original genus Gadiculus, which was based, in part, on the avowed absence of vomerine teeth, was overthrown by Günther's discovery of such teeth in the specimen taken by the "Porcupine" off the S. W. of Ireland, in 1867 The species under consideration, the only representative, had therefore to lapse to the genus Gadus, and, in the existing classification, could only be placed in the sub-genus Pollachius. In our opinion, however, the fish exhibits so many important peculiarities as to justify the creation, for its reception, of a new sub-genus, which we have defined above. It is certainly the most aberrant of the Gadi, the character of specialization being essentially in the direction associated with an abysmal habitat, although it is not actually confined to depths beyond the reach of surface influences.

The muciferous cavities, so far as can be judged from a careful examination of many specimens, both in the fresh and preserved conditions, appear to be entirely exposed to the action of the water, with no enveloping membrane. It must be added, however, that all were more or less injured, the scales, and in some cases, great part of the skin, having been frayed off, a result, no doubt, attributable to the presence of an enormous number of "Sea Urchins" * in the trawl. The specimen figured (Pl. XLI., fig. 1) is the most perfect in the Survey Collection, and was taken from the stomach of a larger fish. It is the only one which permits of a computation of the number of rows of scales crossing the lateral line, in this case 59.

The muciferous cavities (fig. 1*a*) are much more conspicuous in adults than in small examples, but they can be distinguished in specimens only $1\frac{3}{4}$ inch long. Such, however, do not show the scaleless fossa on the nape, while the posterior

* *Spatangus Raschii.*

median cavity of the occiput is relatively narrower than in full-grown fish. Specimens of an inch exhibit only the cavities of the snout. The obliquity of the jaws is a feature which appears also to increase with the growth of the individual.

Examples of less than 3 inches show very little coloration, except the silvery pigment of the sides of the head and abdomen; but the top of the head and the dorsum are speckled with dark chromatophores. These, in specimens of about an inch, show a tendency towards an arrangement into five short transverse bars, of which some traces remain in specimens of 3 inches. Larger examples show the general dull silvery coloration so well depicted in Guichenot's figure of the type.

From the examination of our specimens it appears that vomerine teeth are always present in young examples, though are few in number and loosely attached. They are altogether wanting in many of our larger specimens. The species is thus common along the west coast of Ireland at suitable depths, and is evidently there gregarious at all stages of its existence, as also, according to Vaillant, in the regions explored by the "Talisman" and "Travailleur." The importance to be attached to the occurrence of only young examples, on the Irish coast, above the 100-fathoms line may perhaps be overrated, since the net in which they were caught was a small shrimp trawl,* which might well be evaded by larger examples. The absence of small examples from greater depths may very probably mean nothing more than that the meshes of the larger trawls were not fine enough to retain them. At the same time it must be noted that fishes at least as active as full-grown *G. argenteus* were not infrequently taken in the small net, while it is probable that, if any quantity of small examples had passed through the meshes of the larger trawls, some would have been found adhering to the spines of the Spatangi. It is also possible that the comparatively late development of the mucous cavities of the head may be in relation to some developmental change in the vertical habitat of the species. As we have seen above, it is one which lives, as it were, on the borders of the abyss, never rising into quite shallow water, and never, apparently, penetrating into very great depths.

Genus **Mora**, Risso.

Body moderately elongate, covered with scales of moderate size. A separate caudal; two dorsal and two anal fins; ventrals composed of six rays. Teeth small, curdiform, of equal size, in the upper jaw in a band; teeth on the vomer and sometimes on the palatine bones. Branchiostegals seven. (Günther.)

* Sts. 114 and 115.

Mora mediterranea, Risso. (Deep-sea.)

(Pl. XXXIX., fig. 3; Pl. XLIV., *A* and *A'*.)

Mora mediterranea,	. . .	Risso, "Ichth. Nice.," p. 116.
,, ,,	. . .	Bonaparte, "Faun. Ital. Pesc.," pl. xxiii., fig. 1.
,, ,,	. . .	Canestrini, "Arch. Zool.," ii., p. 359, pl. xi., xii.
Asellus canariensis,	. . .	Valenciennes, Webb. et Beeth., "Hist. Nat. d. Iles Canar. Poiss.," p. 76, pl. xiv., fig. 3.
Mora mediterranea,	. . .	Lowe, "Proc. Zool. Soc. Lond.," 1843, p. 91.
,, ,,	. . .	Günther, "Cat. Fish. Brit. Mus.," 1860, vol. iv., p. 342.
,, ,,	. . .	Capello, "Peix de Port.," 1880, p. 30, No. 141.
,, ,,	. . .	Vaillant, "Exp. Sci. dei Travaill. et d. Talism., Poiss.," Paris, 1888, p. 298.
,, ,,	. . .	Holt, "Proc. Roy. Dub. Soc.," vol. vii., 1891, p. 122.

Synonymy of Young Examples.

Pharopteryx benoit,	. . .	Rüppell, "Verzeichn. Mus. Senckent. Fische," p. 16.

Diagnosis of Species. (Br. vii.: D. 7–8 / 42–44; A. 15–18 (+ 3)* / 15–20; L. lat. 87–95. Vert. 51†).—Barbel slender, black, much shorter than eye. Both anal fins below posterior two-thirds of second dorsal, sub-continuous, the apparent interspace occupied by three minute rays. Anterior ray of first dorsal produced into a short filament. Margin of second dorsal indented. Two outer rays of pelvic fin filamentous, the second ray the longer, reaching beyond anus which is situated slightly anterior to the median point. Lateral line slightly curved at anterior region. Scales large cycloidal, longer than broad.

Length of head about $4\frac{1}{4}$ to $4\frac{3}{4}$ in length of fish without caudal. Total length of fish fully $5\frac{1}{2}$ times extreme depth. Diameter of eye, 3–$3\frac{1}{3}$ in length of head, greater than snout.

Interorbital space $\frac{1}{4}$ in length of head in adults. Snout broad, obtuse. Upper jaw the longer. Opening of mouth extending to beneath centre of eye. Teeth of both jaws cardiform, in bands, widest anteriorly. A toothless interspace at anterior

* The three minute rays, included in the bracket, may be omitted from the formula, as appears to have been done by previous writers. They appear to us to be connected with the first anal fin, if specially with either.

† The number of vertebræ is taken from Günther (Cat., vol. iv., p. 342).

angle of upper jaw, for reception of a prominence on mandibular symphysis. Cardiform teeth on vomers, slightly more conspicuous than those of jaws. Cardiform teeth also on palatines, except in very young examples.*

Colour, brownish grey on back, dull silvery grey on sides and belly,† antero-superior region of first, and margin of second dorsal fins, black or dark grey. Pectorals and caudals, black or dark grey. Pelvics and anals, light grey. Jaws, black or dark grey; mouth, black.

Locality and Distribution.—Only three specimens were taken, all in one haul of the trawl at 500 fathoms, fifty miles off Achill Head, Co. Mayo, on the 10th July, 1890. As the trawl was only shot on one other occasion at a similar depth, and was then reversed for certainly some part of its course, it is impossible to form any opinion as to the abundance or rarity of the species off the west coast of Ireland at such depths, but the negative evidence of a number of hauls seems to show that it is certainly not common nearer the 100-fathom line.

The species was known to have a considerable horizontal range, but had not previously been taken north of the Bay of Biscay, whilst its absence from the collections of the "Porcupine," "Knight Errant," and "Triton," and of the Norwegian North Atlantic expedition renders it probable that the western coasts of Great Britain are about the most northerly point to which it extends. On the other hand it is known to exist as far south as the Canary Islands (Valenciennes and Vaillant), and to extend also into the Mediterranean (Risso and Bonaparte). It is also known from Madeira (Lowe), and from the coast of Portugal (Capello and Vaillant). The author last quoted is our authority for its occurrence in the Bay of Biscay. Dr. Günther ("Challenger," vol. xxii. p. 83) remarks that the specimens taken by the "Challenger" were unfortunately destroyed on board, but does not state the locality of capture.

The species appears to be exclusively confined to deep water in whatever latitude. According to Valenciennes, it used to be regularly fished for off the Canaries at depths of 100 to 200 fathoms; Lowe found it at 300 or 400 fathoms off Madeira, but Vaillant, whose records deal in all with the capture of twenty specimens, found none at less than 332 fathoms, and extended the known limits of its range to 740 fathoms. We have no information as to the maximum size reached by this species, but the largest specimen taken during the cruises of the "Travailleur" and "Talisman" appears to have measured 42 cm. in length, *i.e.* 30 cm. smaller than the largest specimen taken during the Survey. This large

* Doubts were expressed by Günther in 1860 as to whether the absence of teeth from the palatines (in virtue of which Rüppell established his species *Pharopteryx benoit*) was really of specific value; and Valliant has since been able to demonstrate, from material collected by the "Talisman" and "Travailleur," that the character has merely a developmental significance.

† There was no trace in our specimens of the greenish colour shown in Bonaparte's figure.

specimen was a female almost ready to spawn, and judging from this condition it seems probable that, off the Irish coast, spawning occurs about the end of summer.

Description of Specimens.—Only one of our specimens appears to be adult. It is a female, with ovaries approaching ripeness. Its dimensions are as follows:—

	CM.	IN.
Total length,	72	$28\frac{6}{16}$
Total length, without caudal fin,	65	$25\frac{4}{8}$
Length of head,	14	$5\frac{1}{2}$
Horizontal diameter of eye,	4·3	$1\frac{1}{16}$
Vertical diameter of eye,	4·1	$1\frac{0}{16}$
Length of snout,	3·5	$1\frac{3}{8}$
Length of barbel,	1	$\frac{3}{8}$
Interorbital space,	4·1	$1\frac{0}{16}$
Tip of snout to commencement of 1st dorsal fin,	18	$7\frac{3}{8}$
,, ,, ,, ,, 2nd ,, ,,	24	$9\frac{7}{16}$
,, ,, ,, ,, pectoral fins,	16	$6\frac{5}{16}$
,, ,, ,, ,, pelvic fins,	11	$4\frac{5}{16}$
,, ,, anus,	31	$12\frac{3}{16}$
Greatest height of head,	10·5	$4\frac{1}{8}$
,, width of head,	11	$4\frac{5}{16}$
,, height of body,	13	$5\frac{1}{8}$
,, width of body,	9·7	$3\frac{3}{16}$
Height of caudal peduncle,	3	$1\frac{3}{16}$

We have thus before us an elongate fish, in which the length of the head is contained about $4\frac{2}{3}$ times, and the greatest height of the body five times in the total length without the caudal fin. The eye, which is somewhat longer than high, is contained about $3\frac{1}{4}$ times in the length of the head. It exceeds the length of the snout, and its vertical measurement is equal to the width of the inter-orbital space, and more than four times the length of the slender barbel. The anus, opposite the ninth ray of the second dorsal fin, is slightly anterior to median.

The snout is obtuse, bluntly equilateral as seen from above. The upper jaw is distinctly longer than the lower, and the angle of the somewhat oblique gape is a little in front of the level of the centre of the eye. The head reaches its greatest height just behind the eyes, and its greatest width about the middle of the gill-cover. The body is highest and widest at about the middle of the first dorsal; thence the height decreases gradually towards the anal region, and thereafter more rapidly, until, at the caudal peduncle, it is less than the length of the snout. The peduncle terminates, amongst the insertions of the caudal rays, in a lanceolate process. Its total length, from the end of the 2nd dorsal, is 5·5 cm., and from the

end of the 2nd anal, 8 cm., since the last-named fin does not extend quite so far back as the dorsal.

Fins. (D. I. 8; D. II. 44; A. I. 17 (+ 3); A. II. 20; P. 19; Pelv. 6, Caud. 38, *ca.*).—The pectorals do not reach the anus; the pelvics, of which the two outer rays are elongated, extend a little beyond the level of the commencement of the first dorsal. The anterior ray of the first dorsal is elongate, and terminates in a filament. It has a total length of 8·5 cm., but has evidently been at some time broken off at about half its present length, and the distal portion appears to be a new growth, and therefore probably shorter than normal. The second ray is a stout arthroneme, 7·8 cm. long; the succeeding rays are shorter, the last being minute, so that the outline of the fin, apart from the first ray, is roughly triangular. There is hardly an interspace between the two dorsal fins, their membrane being continuous. There is a distinct indentation of the outline of the second dorsal, due to inequality in the length of its rays. Thus the anterior rays are 5·3 cm. in height, but at a point somewhat behind the middle (of the fin) the height of the rays decreases to 4·5 cm., increasing again to 5·3 at the thirty-first ray. The rays posterior to this decrease very rapidly, so that the end of the fin is oblique in outline. The incurvature of the dorsal margin is much better marked in this specimen than is shown in fig. 3, Pl. XXXIX., which is a sketch of a younger example, in which the condition of the fin-rays leaves some doubt as to the natural outline.

The first anal reaches its full height at about the fourth ray, and decreases towards its posterior extremity in the usual fashion. The seventeenth or last ray of the fin proper is very short but stout, and is separated from the short and very stout ray which is the first of the second anal fin by an interspace of 2·7 cm. The fin membrane, however, is continuous, though much reduced, and from it emerge the tips of three minute and very slender rays. Since the ray, which we have alluded to as the first of the second anal, has all the characters of the anterior ray of a fin, it seems that these three minute interstitial rays must belong to the first anal, if specially to either. As a matter of fact, however, they evidently belong to a primitively continuous fin, and therefore not specially to either of the present (otherwise) separate fins. The reduction of the rays in the central region of the second dorsal is evidently a step in the direction of a sub-division of that fin; and thus in the genus Mora we have an interesting illustration of a stage in the evolution of separate fins from the continuous primordial fin or fin-membrane.

The diagrams on pp. 440 and 441 are designed to demonstrate this more forcibly. The figures are intended to show the fins of the adult co-existing with the primordial fin-membrane of the larva.

Figure *A* represents the lowest term in the Gadoid series in which a distinct caudal fin exists, exemplified by the genus *Brosmius*. That this condition is derived

from a hypothetical ancestral form in which the median fins were entirely continuous round a diphycereal caudal extremity need hardly be suggested; while such a condition is apparent to this day within the limits of the Gadoid group in such forms as *Fierasfer* and *Ophidion*. The latter, however, can hardly be cited as *retaining* the ancestral condition, since our knowledge of their phylogeny leaves it uncertain that their present conformation (especially in the case of the parasitic *Fierasfer*) may not rather be indicative of a degeneration from a degree of specialization, conforming more nearly to that exhibited by the higher members of the group. There is, perhaps, less occasion for such speculation in the case of the Lycodidæ, and, in any case, all our knowledge of the evolution of the Ichthyopsida points so distinctly to the derivation of the present divided and median fins from an originally continuous organ, that the matter need not be further dwelt upon.

In *Brosmius* (fig. *A*) it will be noted that the dorsal and anal fin rays are not of equal height throughout, those in the central parts of these fins being so far reduced as to impart a slight incurvation to their outlines, a phenomenon which may be recognised as the inception of a sub-division of the single dorsal and

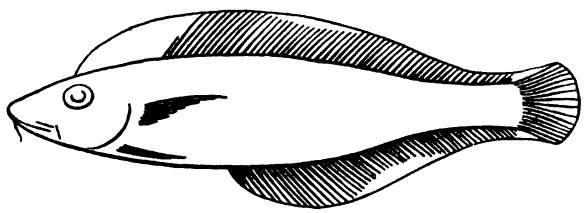


Fig. *A*.

anal into more numerous elements. The condition of *Molva*, *Merluccius*, *Phycis*, *Haloporphyrus*,* &c., may either come next in the series, or may possibly be parallel to that of *Brosmius*. The former have a short, separate first dorsal and a long second dorsal, which, like the anal, show an incurvation of the outline, practically identical in position with that which we have noted in *Brosmius*. We are acquainted with no form in which the separation of the first dorsal (of *Merluccius*) is foreshadowed by a reduction in the length of the rays comparable to that apparent in the posterior part of the whole fin, but in such a form as *Raniceps* we have perhaps a stage in the degeneration of a short separate first dorsal, and in *Motella* of its specialization to subserve a function in no way connected with natation.† It is possible, therefore, that the present condition of the dorsal in *Brosmius* may have been arrived at by the consummation of such a process of degeneration of a separate first dorsal as appears to be exemplified by *Raniceps*,

* *Cf.* figs. 1 and 2, Pl. xxxix.

† We allude to the peculiar ciliary function of this fin, but are unable to offer any interpretation of its value.

but the forward extension of the fin in the former genus seems to render this rather unlikely, and to suggest that the fin-stage, in other respects parallel to that of *Merluccius*, &c., diverges so far from the general line of Gadoid evolution as to show no trace of the separation of a short first dorsal.

In *Mora* (or *Halargyreus*) (fig. *B*), we have a distinct advance, since the short first dorsal is already separate, while the outline of the posterior portion shows strong incurvation in its central region, while the anal is only continuous through

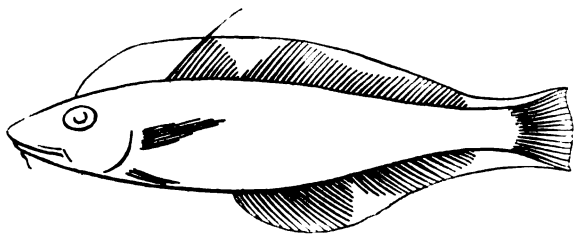


FIG. *B.*

the medium of the three very minute rays already alluded to. The transition to *Gadus* (fig. *C*), the highest fin-stage in the series, is very easy, but since the present condition in the fins of that genus seem to indicate a contemporaneous sub-division of dorsal and anal, it is evident that evolution has proceeded in so far

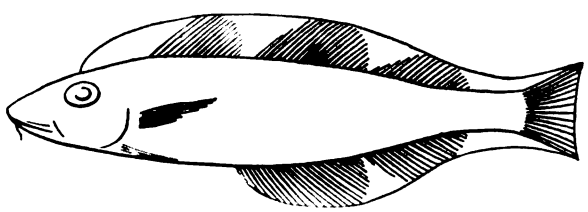


FIG. *C.*

as regards the relations of the different parts of the primordial fin-fold along a line slightly different to that exemplified by *Mora.*

Teeth.—Small, slightly curved, cardiform teeth in a band, widest anteriorly on each præmaxilla. A toothless interval between the bands for the reception of an eminence of the symphysis of the mandibles. Teeth on dentaries similar to those of præmaxillæ. Small cardiform teeth in a curved patch on each vomer, slightly more conspicuous than those of jaws. A small patch also on each palatine.

Scales.—Present on the body, fins, and head, except on the jaws. Large, oblong, slightly convex anteriorly and posteriorly; not much longer than broad on the sides of the body, but becoming very elongated towards the dorsal and ventral region. There are 90 rows of scales crossing the lateral line, and about 25 scales in a transverse row from the first ray of the second dorsal. About 8 or 9 of these are above, and about 15 or 16 below the lateral line: the condition of the

specimen does not permit of our being more exact. Vaillant remarks that the scales are "assez caduques," but in this and in the specimen figured they could by no means be described as deciduous, though in the third example from the Survey they are almost entirely wanting.

Lateral line.—Rising in a very gentle curve in front of the anal region: the posterior portion straight.

Colour.—Brownish grey on the back, dull silvery grey on the sides and abdomen. Pectoral fins dark grey, caudal nearly black, pelvic fins colourless. Antero-superior part of first dorsal black, second dorsal edged with very dark grey. Jaws very dark grey. The colours are little affected by preservation in alcohol, except that the sides lose much of their silvery appearance. The mucous membrane of the mouth, and the peritoneum of the body-wall are black.

The colours in Valenciennes' figure ("Hist. Nat. Iles. Canar.," *loc. cit.*) appear to be fanciful. The figure is concisely criticised by Günther ("Cat.," *loc. cit.*) as bad. It has further attracted the attention of Vaillant, who remarks, as also in the case of the figure given by Bonaparte, that it fails to show the great size of the eye as compared with the length of the snout.

The remaining specimens measure, respectively, 30·5 cm. (12 inches) and 22·8 cm. (9 inches). The larger is represented in the sketch (Pl. xxxix., fig. 3).

The small ones differ from the largest specimen only in such details of proportion as may be supposed to vary with the age or size of the individual. Thus the eye is relatively larger, viz. about one-third the length of the head, and its vertical measurement slightly exceeds the width of the interorbital space. The length of the head is about equal to the greatest height of the body, and either measurement is contained only about $4\frac{1}{2}$ times in the total length without the caudal fin. The somewhat bolder curve of the anterior part of the lateral line is perhaps attributable to similar causes. The statements made in describing the median fins of the largest example apply equally to the smaller ones, except that the anterior ray of the first dorsal is perfect in the latter, and its condition would seem to indicate that the filamentous termination is of no great length in this species. There is, of course, some slight difference in the number of fin rays, the formula for all three specimens being as follows:—D, i. 7–8; D, ii. 43–44; A, i. 16–18 (+ 3); A, ii. 17–20. All three examples have teeth on the palatine bones. The specimen figured agrees in colour with the largest, and has retained its scales in tolerably perfect condition, but the smallest example is almost entirely scaleless, and altogether paler in colour. This is especially noticeable in the distal part of the dorsal fins, where no loss of scales could possibly affect the colouration. It is, no doubt, a pale variety, such as we know from Cuvier and Valenciennes ("Hist. Nat. Poiss.," vi., p. 495), and Lowe (P. Z. S., 1843, p. 91), to exist in *Pomatomus telescopium*. Lowe, indeed, compares the colour of *Mora*

mediterranea to that of *Phycis mediterraneus* or of a *pale* specimen of *P. telescopium.* Both our Irish examples of the last-named species belong evidently to the pale variety, and, except for the purplish ("gorge de pigeon," Valenciennes) hue on the gill cover, are not unlike the darker specimens of Mora, but they are decidedly darker than the smallest example.

Anatomy.—On opening the abdominal cavity, the peritoneum is seen to be of an intense opaque black; and the general appearance of the viscera and mesenteries is striking on account of their strong muscular character. (Plate XLIV., *A.*) On examining the viscera a singular torsion towards the right side is noticeable, so that several organs which usually occupy lateral positions are found in the median plain. The amount of this displacement may be estimated if we suppose that a cross-section of the abdominal cavity represents a circle divided into four compartments, thus: X; and if, after having filled in the viscera of a Gadoid in the normal positions, we turn the subdividing lines on their axis, the extent of one interval, or section of the cross, to the right-hand, imagining the view of the viscera to be from the anterior aspect. The liver, for instance, has two large lobes and one small central lobule. This central lobule, which, in ordinary circumstances, may be seen in the ventral median line, occupies the right side; while the lobe of the right side occupies a dorsal median position, and the lobe of the left side a ventral median position. In the same manner the reproductive organs lie, not side by side, but are above the other, the organ which in ordinary conditions would occupy the right side being in the dorsal position. The strong mesenteries maintain this arrangement. Those in connexion with the reproductive organs form a great sheath passing forwards on the dorsal surface of the stomach, below the dorsal lobe of liver, a branch bending round the left side of the stomach to support the ventral lobe of the liver. The dorsal lobe of liver is the longest, and extends backwards about two-thirds of the abdominal cavity. The stomach is large, with a wall of great muscular thickness, especially on the dorsal aspect. In the specimen under examination, the wall, at its thickest, measured 1¼ inches. The torsion, already referred to, causes the duodenum to spring from the right side. The lumen is narrow, and the intestine, after making two simple bends so as to form a long, much flattened S, passes to the anus. There are twenty pyloric cæca, which bend laterally and posteriorly, encircling, to a certain extent, the ventral lobe of liver.

The swimming bladder exhibits a condition of great interest. A lateral view of the organ, after the removal of its right side, is seen in Plate XLIV., *A.* It consists of two primary portions: the larger situated partly above and partly posterior to the abdominal cavity; the smaller situated in front of this, partly above the thoracic region, and partly in the region of the head. Those two portions are in communication with one another by means of a canal sunk into

the lower surfaces of the bodies of the 6th, 7th, and 8th vertebræ, but not enveloped by bone. The larger portion is comparatively simple, but wide and capacious, being fully two inches at its broadest. It has towards its anterior end an imperfect horizontal septum, forming an upper and lower compartment. The upper ends blindly, the lower communicates with the canal leading to the anterior portion of the bladder. The lower wall bears two circular rete mirabile below the posterior end of the septum. These are placed one behind the other, and the more anterior one has, immediately above it, a circular opening in the septum, so that, when the bladder is not fully inflated, it can project into the upper horizontal compartment. At the extreme posterior end of this portion of the bladder there is another rete mirabile, formed so as to fit what may be termed the fundus of the bladder. The anterior portion of the bladder is first of all completely divided into two sections, as seen in the figure. The lower section is formed by an extremely delicate membrane, and appears, when looked at from the ventral aspect, to be laid upon the under surface of the firmer and more important section of the bladder. The attachment of the membrane, however, is found to be fibrous and well defined, while the anterior half bears a flattened disc-like rete on its lower surface. The upper section may be said to be naturally divided into two lateral cavities by the anterior portion of the vertebral column, and by the occipital region of the skull. Those cavities communicate with one another at their posterior ends by a passage under the vertebral column. The figure shows only the cavity on the right side of the head, a diagrammatic outline of the bladder as seen from above being given in fig. *A'*. Each lateral sac is attached by strong fibrous bands posteriorly to the body of the 5th vertebra, and anteriorly to the posterior surface of the pterotic bone.

A median attachment is also secured to the first five vertebræ of the column and to the basi and exoccipital bones.

Each lateral cavity may, therefore, be spoken of as passing forwards, upwards, and outwards from below the level of the fifth vertebra, under both branches of the post-temporal bone, between the supra-scapula and the exoccipital bones, to the posterior surface of the pterotic. The passage leading from the cavity of one side to that of the other has situated in it three circular rete mirabile, and is, in the specimen figured, of sufficient size to admit the little finger. Into this passage the canal leading from the larger or posterior portion of the bladder opens. At no part of the air-bladder is there any pneumatic duct in connection with the alimentary tract.

The kidneys remain to be mentioned. They are situated in the normal position, immediately superior to the swimming-bladder, but as in other deep-sea fishes are much prolonged. There are two distinct head-kidneys which could not be shown in the figure, as it was necessary to dissect the right one away, along with

the post-temporal bone, in order to show the head portion of the air-bladder. In the body-region, the kidneys become flattened and thin, and unite in a more or less indefinite manner when they are about the level of the posterior end of the abdominal cavity. At the extreme posterior end of the bladder this single organ is reflected downwards to form a thickened mass, roughly pyramidal in shape. This may be seen in the figure.

We have not examined the skeletal anatomy of any of our specimens since we know from Günther's observations ("Cat." *loc. cit.*) that the species presents no points of special interest in this respect.

Vaillant has described and figured the Sagitta.

Genus **Merluccius**, Cuvier.

Merluccius vulgaris, Fleming. The Hake. (Deep-sea.)

M. vulgaris, ...	GOODE, "Proc. U. S. Nat. Mus.," iii. 1881, pp. 337, 476.
,, ,, ...	GOODE, "Bull. Mus. Comp. Zool.," x., 1883, p. 207.
,, ,, ...	VAILLANT, "Exp. Sci. Trav. Talism., Poiss.," p. 300.
,, ,, ...	HOLT, "Sci. Proc. R. Dub. Soc.," vii., p. 219.

Hake were taken during the Survey at 115 and 220 fathoms off the coast of Kerry, and at 154 fathoms off the coast of Mayo. The species also occurred abundantly in shallow water. On the New England coast, hake have been taken at a maximum depth of 487 fathoms, spawning examples being secured at depths between the last-mentioned and 250 fathoms (Goode). Vaillant records the species from a maximum depth of 346 fathoms off the N.W. coast of Africa.

Genus **Phycis**, Cuvier.

Phycis blennioides, Brünner. The Fork-beard. (Deep-sea.)

P. blennioides, ...	STROM., "Norst. Vid. Selsk. Skr.," 1881, p. 76, 1884, p. 35.
,, ,, ...	COLLETT, "Nyt. Mag. f. Naturvid.," 1884, p. 83.
,, ,, ...	GÜNTHER, "Ann. Mag. Nat. Hist.," iv., 1889, p. 417.
,, ,, ...	SCHARFF, "Proc. Roy. Ir. Acad.," 3rd S., i., 1891, p. 457.
,, ,, ...	HOLT, "Sci. Proc. Roy. Dub. Soc.," pp. 122, 219.

Fork-beards were taken during the Survey at 154, 220, and 375 to 500 fathoms off the coast of Kerry; and a young example occurred at 26 fathoms in

the Kenmare River. A single specimen was taken off the S.W. coast by the "Flying Fox" at 150 fathoms. Others were secured by the "Lord Bandon" in the same locality, but the depth is not stated. On the Norwegian coast the species has been recorded from a maximum depth of 200 fathoms. It occurs regularly in the comparatively deep part of the North Sea (about 40 to 50 fathoms) to the northward of the Great Fisher Bank, and has occasionally been taken at many points on the British coast, although no records of the depths are available. In addition to the instances cited above, only a few specimens have been recorded from Irish waters. The species extends along the Atlantic coasts to the Mediterranean, where it is common, and, apparently, littoral in distribution. On our own coasts it certainly appears to be most usually met with in rather deep water, and is, probably, by no means uncommon below the 100-fathoms line of the western slope.

Phycis Aldrichii, Bourne. (Deep-sea.)

P. Aldrichii, ... Bourne, "Journ. M. B. Assoc.," N. S., i., 1890, p. 310.

The only known examples of this species were obtained by Mr. Bourne at 200 fathoms off the S.W. coast of Ireland.

Genus **Haloporphyrus**, Günther.

Body elongate, covered with small scales. A separate caudal; two dorsal fins and one anal, the first dorsal with four rays; ventrals narrow, composed of six rays. Jaws with bands of villiform teeth; vomerine teeth in a small roundish patch; none on the palatine bones. Chin with a barbel. Branchiostegals, seven.

Haloporphyrus eques, Günther. (Deep-sea.)

(Pl. xxxix., figs. 1 and 2.)

H. eques, ... Günther, "Chall. Rep.," xxii., p. 91.
" . . . . . Bourne, "Journ. M.B. Assoc.," N.S., i., p. 311.
" . . . . . Scharff, "Proc. Roy. Ir. Acad.," 3rd S., i., p. 459.
" . . . . . Holt, "Sci. Proc. Roy. Dub. Soc.," vii., p. 122.

Diagnosis of Species.—(D, i. 4; D, ii. 56–62; A. 49–54; Pelv. 7; L. lat. 180; Cæc. pyl. 10–11.)—The length of the head equal to, or rather less than, the

distance between the origin of the pelvis and the anal, and rather less than one-fourth of the total length (without caudal). The eye longer than the snout by one-third the length of the head, and nearly twice the width of the inter-orbital space. Snout obtuse, with an undulated series of pores in the pre-orbital region, running towards the extremity of the snout. Barbel about half the length of the eye. Angle of the gape opposite or a little in front of the centre of the eye. Caudal peduncle very slender, its height being about two-fifths of the distance between the dorsal and the caudal, or a little more than one-fourth of the length of the eye. Fifteen or sixteen longitudinal series of scales between the first dorsal and the lateral line. The first long dorsal ray compressed, moderately strong, extending back beyond the centre, frequently to the posterior fourth, of the second dorsal fin. Of the second dorsal and anal, the outline of the latter is especially incurved in its central region. Caudal rounded, its external rays extending some distance along the peduncle. Pectoral, as long as the head without the snout. Pelvic, with the two outer rays elongated and filamentous, equal to the length of the pectoral, and united along their proximal half.

Colour.—Brownish or dull silvery grey, darkest on the dorsum; fins dark grey, those of the median series nearly black on the marginal parts.* Cavities of the mouth, gills, and abdomen, black.

Size.—Not known to exceed a total length of 13 inches.

The species has been excellently described and figured by its discoverer; and our own description, which differs in no important respect from that given by Dr. Günther, is inserted only in accordance with the plan of the present Paper.

The larger specimen, shown in fig. 2, has the long dorsal ray broken, the slender extremity representing apparently a growth which has taken place subsequently to the original injury. The figure is taken from the preserved condition, which accounts for the shrunken appearance of the skin over the muscous cavities of the head.

The smaller specimen (fig. 1), has the first ray complete, but extending only to about the centre of the second dorsal fin. The barbel is not shown, being turned back in the gular groove. Apart from the mere obvious developmental differences, it will be noted that the anus, in the larger, is comparatively more remote from the anal fin than in the smaller example. A similar condition is shown in the specimen figured by Günther (*op. cit.*, pl. xviii., fig. *B*). This decrease of measurement between the anus and the pelvic fins may probably

* According to Günther (*loc. cit.*), "specimens of a much lighter colour (probably albinos) are not scarce."

occur with the growth of the individual, as is the case in some species of Macrurus.

Locality and Distribution.—The Survey examples are five in number, and were all taken at 500 fathoms, 54 miles off Achill Head. So far as is at present known, the species is confined to the deep water in the neighbourhood of the British Isles. It appears to be abundant in the Faroë Channel, where the first specimens were taken by the "Knight Errant," at 530 fathoms, in 1880 (Günther). On the Irish coast the first example was secured by the "Flying Falcon," at 750 fathoms, in 1881 (Scharff); while another was taken by the "Research" in the following year (Bourne).

Genus **Molva**, Nilss.

Molva vulgaris, Fleming. The Ling. (Deep-sea.)

M. vulgaris, ... Collett, "Nyt. Mag. f. Naturvid," 1884, p. 84.
,, ... Lilljeborg, "Sverig. o. Norg. Fisk," p. 131.
,, ... Holt, "Sci. Proc. R. Dub. Soc.," vii., pp. 122, 219, 441.

Specimens were taken during the Survey at 127 and 154 fathoms off the coast of Mayo, as well as in littoral waters. Ling are constantly taken on the Norwegian coast at depths exceeding 100 fathoms, the largest, according to Lilljeborg, coming from 80 to 150 fathoms, while Collett remarks that young examples are rarely taken at less than 100 fathoms. On our own coast, as has been pointed out by one of us,* the young are not infrequent in quite shallow water.

Off the Faroë Islands ling are regularly taken on the long lines at depths exceeding 100 fathoms; but there is difficulty in obtaining from the fishermen, who are our informants, exact information as to the maximum depth at which the species has been caught.

* Holt, *supra*, iv. 91, p. 96.

Genus **Motella**, Cuvier.

Motella cimbria, Linnæus. (Deep-sea.)

Onus cimbrius, ... GOODE and BEAU, "Proc. U. S. Nat. Mus.," iii., 1881, p. 476; "Bull. Mus. Comp. Zool.," x., 1883, p. 207.

M. cimbria, ... SCHARFF, "Irish Naturalist," 1893, p. 176.

This rockling was not known from Irish waters at the time of the Survey, but, in suggesting it as the possible parent of a Motella-like ovum and larva, doubts were expressed by one of us* as to how far its absence from the Irish list could, in the existing stage of our knowledge of the Irish fish-fauna, be held to invalidate the suggestion. The parentage of the ovum remains in doubt, but the adult has since been added to the Irish list by Dr. Scharff. It is only known in the old hemisphere as a littoral form, but has been recorded from the American coast at 178 fathoms.

Motella tricirrata, Bloch. (Deep-sea.)

M. tricirrata, ... VAILLANT, "Exp. Sci. Trav. Talism. Poiss.," p. 285.

The three-bearded rockling was taken in the French dredging expedition at a maximum depth of 346 fathoms off the N.W. coast of Africa. "Mackerel-midges," apparently belonging to this species, were frequently taken at the surface during the Survey, but no adult forms were met with at any depth.

Genus **Brosmius**, Cuvier.

Brosmius brosme, Müller. The Tusk or Torsk. (Deep-sea.)

B. brosme, ... GÜNTHER, "Proc. Roy. Soc. Edin.," 1882, p. 680.

,, ... LILLJEBORG, "Sver. o. Norg. Fisk," ii., p. 202.

,, ... SMITT, "Hist. Skand. Fish.," ed. 2, p. 562.

Several tusk were taken during the Survey at 250 fathoms off the coast of Mayo. The species is very little known in Irish waters, although it appears to occur regularly off Dingle Bay. Mr. Green, who is our informant in this respect, tells us that the fish is known in that district as the "Cat-ling." It is evident that the fishes alluded to by Day as taken "far out at sea off the Galway coast" belong to this species, and not, as was supposed, to *Anarrhichas lupus*.

* Holt, *supra*, iv., 1891, p. 96.

Günther records the capture of a tusk at 530 fathoms in the Faroë Channel. On the coast of Norway it is said by Smitt to be common at 100 to 200 fathoms. Off the coasts of Iceland and the Faroë Islands it is taken at depths of over 100 fathoms, and also, according to fishermen, in quite shallow water.

Fam.—**MACRURIDÆ.**

Genus **Macrurus**, Günther.

Head generally with large muciferous cavities. Snout frequently projecting beyond mouth, which may be inferior, or sub-terminal and lateral. Jaws armed with small teeth: no teeth on the palate. A barbel on the mandibular symphysis. Scales cycloid or ctenoid. The second dorsal always less developed than anal, its rays frequently rudimentary in front or throughout.

Four gills. The slit between gill cover and first branchial arch partly obcluded by a broad fold of the membrane of gill cavity so as to be much narrower than the slits between branchial arches. No pseudo-branchiæ. No scaleless fossa on the nape.

For a fuller discussion of the characters of the genus we would refer readers to the "Challenger" Memoir (pp. 122–124), drawing especial attention to Dr. Günther's remarks on the development of the adult characters of the scales, and the changes in proportions. Twenty-nine specimens of Macruri were trawled during the Survey, belonging to four species.

Günther, in his systematic arrangement of the genus, divides it first of all into three sections, which are again divided into subgenera, and in dealing with our material we propose to follow this arrangement, quoting the characters of the subgenera represented, viz.: *Cœlorhynchus*, *Macrurus*, *Coryphænoides*, and *Malacocephalus*. Of these the first three belong to Section I., and the last to Section III. We may add that, for general convenience, we have, in our diagnoses of species, adhered as closely as possible to Günther's descriptions, only altering them in details whereon additional information is furnished by our specimens.

Section I.—Teeth in villiform bands above and below; that of the lower jaw always broadest near the symphysis, and sometimes tapering into a series on the side of the jaw.

A. Scales distinctly imbricate, without enlarged dorsal scales.

1. Scales spinigerous.

a. Mouth entirely on the lower side of the head, a longitudinal ridge dividing the infraorbital region into a vertical and sub-horizontal portion. Dorsal spine smooth.

Sub-genus **Cælorhynchus.**

Macrurus cælorhynchus, Risso. (Deep-sea.)

(Pl. XL., figs. 2 and 2*a*).

Lepidoleprus cœlorhynchus, .	RISSO, "Ichth. Nice," p. 200.
Macrourus cœlorhynchus, . .	BONAP., "Faun. Ital. Pesc." (pl. xxx., *Macrourus mysticetus*).
,, ,, . .	COSTA, "Faun. Nap.," *Gen. macr.*, p. 2.
,, ,, . .	CANESTRINI, "Arch. Zool.," ii., p. 374.
,, ,, . .	JOHNSON, "Ann. Mag. Nat. Hist.," 1862, p. 169.
Macrurus cœlorhynchus, . .	GÜNTHER, "Chall.," vol. xxii., p. 128.
,, ,, . .	GÜNTHER, "Ann. Mag. Nat. Hist.," 1889, p. 417.
,, ,, . .	VAILLANT, "Exp. Sci. Trav. Talism.," Poiss., p. 247.
,, ,, . .	BOURNE, "Jour. M.B.A.," N.S., vol. i., p. 311.
,, ,, . .	SCHARFF, "Proc. R.I. Acad.," 3rd S., vol. i., p. 459.
,, ,, . .	HOLT, "Proc. Roy. Dub. Soc.," vol. vii., p. 122.
Macrurus atlanticus, . .	LOWE, "Proc. Zool. Soc. Lond., 1839," p. 88.
,, ,, . . .	GÜNTHER, "Cat. Fish. Brit. Mus.," vol. iv., p. 392.

DIAGNOSIS OF SPECIES. (D. 9–10*; P. 18–20; Pelv. 7.)—Snout moderately produced, angular in front, a little shorter than, or equal to, the eye, the diameter of which equals three times the distance from tip of snout to base of first dorsal fin-ray. The interorbital space varies from $1\frac{1}{2}$ diameters of eye in specimens of 24 cm. to $1\frac{3}{4}$ in specimens of 12 cm. Scales of moderate size, covered with minute spines, giving a granular appearance to their surface. The spines are not numerous, and are arranged in three imperfect rows, the central being the longest.

There are five or six scales in a transverse row between the first dorsal fin and the lateral line. Dorsal spine smooth. The distance between the vent and isthmus becomes slightly greater with the growth of the individual. In small specimens the vent is situated on a level with the posterior spine of first dorsal fin. Outer pelvic ray produced into a short filament. Muciferous cavities exist in the snout and interorbital region, above the operculum, and round the eye. There is a scaleless oval depression between the pelvic fins, black in colour.

Colours.—Dull silvery grey on the sides and back; black on the abdomen in the region of the pelvic fins.

Size.—The species does not appear to reach a large size. An example measuring 12 inches is mentioned by Günther. In the above diagnosis this specimen, and the smallest of our own, $4\frac{3}{4}$ inches long, must be considered in interpreting the terms "large" and "small."

* The short anterior spine, usually hidden by the skin, is not counted.

Locality and Distribution.—Nine specimens, from 12·1 to 24·7 cm. (4¾ to 9¾ inches) long, were trawled at 144 and 220 fathoms, 40 miles off Achill Head, on the 4th July, 1890.

The species had already been taken on three occasions off the west coast of Ireland, viz. during the expeditions of the "Flying Falcon," "Flying Fox," and "Research." It was previously known from the Mediterranean and off Madeira, and was taken during the expedition of the "Talisman" and "Travailleur" at various points between the Bay of Biscay and the Azores. A young specimen taken from the stomach of a cod-fish near Bergen is believed by Collett to belong to this species,* perhaps the commonest of the European Macruri.

It is one of the few species of Macrurus that has been recorded from above the 100-fathoms line, having been captured on one occasion during the French expedition at 88 fathoms; 345 fathoms, the depth at which it was taken by the "Flying Falcon," represents the opposite extreme of its vertical range, so far as it is known to us.

Description of Specimens.—For the comparison of specimens of different sizes we have chosen a series of five examples, ranging from 12·1 cm. to 23·7 cm. in total length. These we shall speak of as A, B, C, D, and E.

The following is a Table of dimensions of these specimens.

	A.	B.	C.	D.	E.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*
Total length,	23·7	16·0	14·6	13·4	12·1
Length of head,	5·3	3·2	3·0	3·1	2·5
,, snout,	1·9	1·2	1·0	·9	·8
Width of ,,	2·1	1·3	1·3	1·2	1·1
,, inter-orbital space,	1·3	·7	·7	·7	·6
,, head,	3·0	1·7	1·6	1·5	1·2
Greatest height of body,	3·3	1·8	1·9	1·8	1·4
,, width ,,	2·2	1·1	1·1	1·2	1·0
Tip of snout to mouth,	2·0	1·1	1·1	1·0	·9
,, ,, 1st dorsal fin,	6·1	3·9	3·4	3·4	2·8
,, ,, 2nd ,,	8·9	5·5	5·0	4·9	4·0
,, ,, pelvic fin,	5·9	3·1	3·2	3·1	2·8
Greatest diameter of eye,	1·9	1·2	1·1	1·2	1·1
Least ,, ,,	1·5	·8	·8	·8	·7
Vent to isthmus,	3·3	2·0	2·0	1·9	1·7

From the above Table it will be seen that the increase of length of the species

* "Norges Fisk," p. 129.

is accompanied by a steady increase in the dimensions of the various parts, and that in no particular does any sudden proportional variation take place. Only one exception appears in column D (13·4 cm.) where the greatest diameter of eye shows an increased measurement when compared with the larger specimen C (14·6 cm.), and the same measurement as the much larger specimen B (16 cm.). In this particular specimen, however, the membrane of the eye, and the muciferous cavities of the head, show very decided evidence of shrinkage, and we are inclined to consider that, if indeed the increased measurement is not due to an individual peculiarity, it may be explained by the shrinkage of the outer membrane.

Fins.—In Günther's description of this species* no variation is shown in the fin-ray formula except with regard to the anal fin, which, on account of the uncertainty which often may occur as to whether or not the entire caudal termination is present, can readily be understood, especially in a species where most of the examples procured have been of small size.

In seven specimens examined by us with regard to the fins, a certain variation takes place, and we have therefore shown it in our fin-ray formula at the commencement of this description. The details are as follows:—

Specimen,	23·7 cm.	1st Dorsal,	10	Pectoral,	18	Pelvic,	7
,,	16·0	,, ,,	10	,,	19 ?	,,	7
,,	16·0	,, ,,	9	,,	18 ?	,,	7
,,	14·6	,, ,,	9	,,	20	,,	7
,,	13·4	,, ,,	10	,,	18	,,	7
,,	incomplete	,, ,,	10	,,	—	,,	7
,,	12·1	,, ,,	9	,,	20	,,	7

Johnson (*loc. cit.*), describing some specimens taken at Madeira, gives the number of fin-rays in the second dorsal as 98, and in the anal 110. His largest specimen was $13\frac{1}{2}$ inches in length, or 4 inches longer than the largest specimen in the above Table. Günther gives 75–86 as the numbers applicable to the second dorsal.

Abdominal Viscera.—On opening the abdominal cavity, the oval depression is seen to be the inferior surface of a gland-like body lying embedded in the abdominal wall. It is flask-shaped, and perfectly black in colour. The neck of the flask forms a canal which runs directly backwards along the inferior surface of the abdomen, in the middle line, until it comes in contact with the opening of the rectum, to which it has a fibrous attachment. A probe can readily be passed along this canal from the gland-like body, but fails to find free access to the rectum. In some specimens of *M. laevis*, trawled at night, a highly luminous fluid was observed to issue from the vent, or from its immediate neighbourhood. No

* "Challenger" Reports, vol. xxii., p. 128.

opportunity occurred of examining by night any other species of macruri during the Survey; but since *M. laevis* also possesses a black, scaleless depression between the pelvic fins, and shows some traces of an internal arrangement similar to that met with in the species before us, it seems possible that this gland-like body may be in some way functional for purposes of illumination.

The peritoneum is thickly speckled with black pigment, but the mouth is white.

The rectum comes almost perpendicularly downwards towards the vent, and the reproductive organs which are situated at the posterior extremity of the abdominal cavity send their ducts forwards and downwards. On the left side a long lobe of liver extends the entire length of the abdominal cavity, and bends into a median position posteriorly. The right lobe of the liver is insignificant, but on this side of the body a fold of the intestine passes backwards. The pyloric coeca are numerous, but not to the same extent as in *M. laevis*. The stomach is large and rounded, the duodenum springing from the centre of the inferior surface.

The viscera completely filled the cavities of the specimens examined; and in an example of fair size (23·7 cm.) which had the appearance of being a mature male, the testes were joined together posteriorly so as to form a single-forked organ.

The air-bladder is attached laterally to the extremities of the transverse processes of the dorsal vertebræ. On opening it, along this lateral line of attachment, the cavity is seen to project to a certain extent backwards beyond the abdominal cavity proper, to the level of the fifth anal fin-ray. It is wide and capacious in extent. Anteriorly, below the dorsal fin, it becomes constricted, and ends behind the head in a somewhat broad point. A convoluted rete lies on the inner inferior surface near the anterior end. The superior membrane of the bladder is imperfect, so that a circular space occurs at a point corresponding with the position of a central muscular opening described in *M. laevis* (p. 477). A portion of the kidney can be seen passing immediately above this opening. There are two head-kidneys continuous with a single body organ, as described below in the case of *M. laevis*.

Skeleton.—The skull is figured by Costa (*op. cit.*, Pl. xxxix.)

SECTION I. *A.*—SUB-SECTION 1 (*supra*).

c. Mouth wide and lateral; dorsal spine serrated.

Sub-genus **Coryphænoides.**

Macrurus rupestris, Gunner. (Deep-sea.)

(Pl. XLIII., fig. 2; and fig. in text.)

Berg Lax, ...	STRÖM, "Sond.," i., p. 267.
Coryphænoides rupestris, . .	GÜNNER, "Trondhj. Selsk. Skrift.," vol. iii., p. 50, tab. iii., fig. 1.
,, ,, . .	COLLETT, "Forhandl. Vidensk. Selsk. Christ.," 1880, p. 70.
,, ,, . .	LILLJEBORG, "Sverig. och. Norg. Fisk.," p. 259.
,, ,, . .	DAY, "Fish. Gt. Brit.," vol. i., p. 335, pl. xciii.
Macrurus rupestris, . .	GÜNTHER, "Challenger," vol. xxii., p. 138.
,, ,, . . .	HOLT, "Proc. Roy. Dub. Soc.," vol. vii., p. 122.
Macrurus norvegicus, . . .	NILSSON, "Skand. Faun. Fisk.," p. 600.
Coryphænoides norvegicus, . .	GÜNTHER, "Cat. Fish. Brit. Mus.," vol. iv., p. 396.
Macrourus Stroemii, . . .	REINHARDT, "K. dansk. Vidensk. Selsk. Afhandl.," vol. viii., p. 129.

Locality and Distribution.—Four examples, varying in length from 67·2 to 96·4 cm. (26½ to 38 inches), were trawled at a depth of 500 fathoms, 54 miles off Achill Head, Co. Mayo, on the 10th July, 1890.

The species was thus for the first time added to the British Fauna, but having previously been taken in the deep channel between the Faroë and Shetland Islands, it cannot be said to be new to British waters. So far as the horizontal range is ascertained, the species appears to to be confined to the North Atlantic, occurring in the waters of both hemispheres.

Thus, on the eastern side, it has been recorded from Finmark and the North Cape (Nilsson), from various parts of the Scandinavian coast (Collett and Lilljeborg), and from the Faroë channel (Günther). On the western side it has been taken off Greenland (Reinhardt), and off the N.E. coast of the United States (Goode and Beau).* The species does not appear in the list of deep-sea forms taken in the "Talisman" and "Travailleur" expeditions; and since the latter vessels worked as far north as the Bay of Biscay it seems unlikely that the species extends much further south, on the European side, than the British Islands, but must rather be considered as a northern form.

* "Bull. Mus. Comp. Zool.," x., 1883, p. 197.

The vertical range is summarised by Lilljeborg, as from 100 to over 500 fathoms, probably with approximate correctness, though we know of no exact record of the occurrence of the fish at less than 200 fathoms. Günther's Faroë examples were taken at depths ranging from 200 to 500 fathoms, and the United States specimen at 524 fathoms, which seems to be the maximum recorded depth.

Diagnosis of Species. (D. 10–12; P. 17–21; Pelv. 7–8).—Head short, rather compressed; snout short, obliquely truncated in front; cleft of mouth wide, lateral, extending to beyond the centre of the eye in adults, but barely reaching the front of the eye in very young examples. Præmaxilla not much shorter than maxilla. Teeth in villiform bands in both jaws: barbel very short. Inter-orbital space convex, its width greater than diameter of eye, which is equal or nearly equal to length of snout, and is about one-fourth the length of head. Scales rough; spinelets directed backwards, present on whole of exposed surface of scales, and longest on scales of ventral aspect of abdomen. Six to nine scales in a transverse series between first dorsal fin and lateral line.* Head entirely covered with small scales. Anterior dorsal spine armed with numerous small closely set serrations, usually absent in large examples from the proximal region of spine; outer pelvic ray produced into a longish filament. Distance between vent and isthmus about two-thirds to four-fifths of the length of the head.

Colouration.—Brownish on the back, dull silvery grey on the sides and belly. Branchiostegal membrane and mouth black. Fins dark grey or black.

Size.—We can find no record of an example exceeding the length of the largest of our series, viz. 96·4 cm. or 38 inches. Günther mentions specimens nearly three feet long, received from Sognefjord. The species appears to reach a larger size than any of its European congeners.

Description of Specimens.—Examination of the four specimens reveals a certain divergence of characters, which at first sight made us think it possible that we might be dealing with members of more than one species. On comparing them, however, with examples in the British Museum from other localities, it becomes evident that such differences as the Irish examples exhibit amongst themselves cannot be regarded as of specific value, but can be sufficiently dealt with by imparting a little more elasticity to the general diagnosis of the species. It will be noticed that, especially with regard to proportions, the diagnosis which we have given on the preceding page permits of a degree of variation somewhat in excess of that defined by Günther in his description of the species in the "Challenger" Memoir. On a casual inspection our specimens arrange themselves into two groups, the most readily noticeable distinction being the greater or less degree of

* This statement is made upon the authority of Lilljeborg (*op. cit.*, p. 259), but seven or eight seems to be the usual number.

obliquity in the anterior profile; in two, including that shown in Pl. XLIII., fig. 2, which appear to conform most closely to the ordinary type in the character alluded to, the anterior profile is only moderately oblique, and the snout is consequently somewhat obtuse, whereas in the two remaining examples it is somewhat sharp.

There exist, moreover, other differences, which, were they associated with those already mentioned, would present some difficulty to the systematist. It happens, however, that they occur independently, since specimens which in some character conform to one type, depart from it signally in another.

To illustrate this more fully we have selected two examples for detailed description and comparison: they may be termed respectively, A and B, the former conforming in the contour of the snout to the normal condition illustrated by the specimen shown in figure 2.

Dimensions.

	A.	B.
Total length,	74·5 cm.	93·90 cm.
Length of head,	15·9	13·80
,, snout,	3·8	3·45
,, eye,	3·3	3·45
,, præmaxilla,	4·9	4·50
,, barbel,	1·0	1·05
Greatest height of body,	12·6	11·60
,, ,, of head,	11·2	9·60
,, width of ,,	7·2	6·60
Width of interorbital space,	5·6	4·55
Distance from isthmus to vent,	8·7	11·40
Tip of snout to first dorsal fin,	15·9	14·30
,, ,, to vent,	17·6	19·20

Proportions.—Owing to the frequency with which the Macruri lose some portion of their caudal extremities, the total length of a specimen, as it comes to hand, is not always a safe unit to use in the computation of proportions, and it happens that example A is certainly short of its natural length by several centimetres. As appears to be usual, fin-rays, presumably from the anal fin, have made their appearance on the mutilated end, simulating a caudal fin, much in the manner illustrated by Günther ("Chall.," vol. xxii., pl. xxx., fig. 2*a*) in the case of *M. serrulatus*.

The distance between the snout and the vent may also be distrusted, owing, as we have seen when dealing with *M. æqualis*, to an irregularity in the position of the vent which manifests itself in several species of Macrurus. But when, as in the case before us, the relations of the vent to the commencement of the anal fin are about the same, the pre-anal length may be considered of some importance.

By adopting it as the unit it becomes at once apparent that the head is relatively longer, and the body relatively higher, in A than in B; to express it more exactly, the length of the head is in A about eight-tenths, in B seven-tenths, and the greatest height of the body (situate in both examples as the anterior ray of the first dorsal) is in A seven-tenths, and in B six-tenths of the length of the fish in front of the vent. B is, in fact, judged by this standard, a more elongate example than A; but if we use the length of the head as the unit, we find the height of the body relatively greatest in B. Such a condition is the reverse of what might be expected from the analogy of other species (since B is considerably the smaller of the two), and therefore tends to demonstrate the importance of the pre-anal length in this particular case. The position of the first dorsal, which is in A opposite to, and in B a little behind, the end of the head, may also be taken as evidence to the same effect.

Turning to the proportions of the head, we find the eye relatively largest in B, viz. it is contained 4 times in the length of the head; in A nearly 4¾ times. The relative dimensions of the snout and eye are also somewhat different, since in B these structures are of equal length, whereas in A the former is slightly the longer. Relatively to the height, the head is somewhat the wider in A. The distance between the vent and the isthmus, a dimension which has been found of use in the specific diagnosis of many Macruri, is naturally dependent on the degree of elongation of the body, or on the developmental migration of the vent, when such occurs. Accordingly in A the distance is not quite equal to two-thirds of the length of the head, while in B it is more than four-fifths of the same dimension. So far as proportions are concerned, the specimen figured agrees very nearly with B.

The net result of the comparison of dimensions appears to be that our specimens show a greater and a lesser type of elongation, or a microcephalous and a macrocephalous condition, of which the latter appears to be the more in accordance with the normal condition (so far as that can be gathered from the literature of the subject). The former type, however, is here associated with what seems to be the more normal proportions of the head, *inter se*.

Conformation.—In A the snout is comparatively blunt, and the anterior profile only slightly oblique, as in the specimen shown in figure 2. The dorsal profile rises in an unbroken curve to the commencement of the first dorsal fin. It is smooth, and destitute of depressions, except immediately behind the snout, where a moderate-sized sulcus occurs, as in figure 2, above the nostrils on either side. The condition, in fact, bears a strong resemblance to that met with in figure 2, the chief difference being that the inter-orbital space is slightly less convex in the specimen figured. In B the anterior profile is much more oblique, forming an angle of about 45°, with a vertical from the tip of the snout. The dorsal

profile is less expanded, a strong sulcus existing in the middle line, somewhat behind the level of the centre of the eye. The muciferous cavities of the head are everywhere very strongly marked; and it is possible that the difference in profile which this (and also the smallest example of our series) presents to the other specimens may be to some extent due to the collapse of these structures from the effects of the preserving fluid, though it cannot be attributed to this cause alone. The shape of the head is otherwise very similar in all three examples, the distinct, but blunt, sub-orbital ridge being about equally well marked in B. In B, however, the margin of the pre-operculum is rather more angular than in the others. Day's figure, which represents a specimen only 6 inches long, shows the margin of this bone exposed, and strongly serrated. In all our examples the whole of the structure is covered with scales, so that the serrations, if they exist, are thereby masked, and, from an examination of Day's specimen (in the British Musuem), we think it probable that the absence of scales is due to injury in the net, and not a natural condition.

In their remaining characters the two specimens, A and B, show so little difference, that, except in a few trifling details, one description will serve for both.

Teeth and Jaws.—The teeth, arranged in bands in either jaw, are villiform; and in the upper jaw those of the outer series are a little larger than the rest, especially near the centre of the gape, where two or three rather large teeth occur on either side. There is a toothless interspace in the centre. The angle of the jaw is behind the centre of the eye (and more noticeably so in the specimen figured), and the scaleless oral groove extends beyond the hinder margin of the orbit.

Scales.—Relatively rather large, beset over the whole of the exposed surface by rather long but not very stout spinelets; the central spinelets noticeably stronger than the rest. The scales on the sides of the body are rather broader than long; thus a scale from near the lateral line at the level of the commencement of the second dorsal fin measures in A ·8 cm. long by 1 cm. broad, and in B ·8 cm. by 1·1 cm. There are eight scales in a transverse row from the base of the anterior dorsal ray to the lateral line in A and B, and either eight or nine in the specimen figured. The presence of the spinelets gives a velvety, or almost a furry, appearance to the skin of large examples such as A or B; but small specimens, such as those taken by the "Porcupine" and "Knight Errant," look very much smoother, and in fact have much the same appearance as specimens of *M. lævis*, so far as the skin is concerned.

Fins.—There are eleven rays in the first dorsal of both specimens, in addition to the very short anterior spine (not counted in the fin-ray formula), which in A is completely buried under the skin. The anterior ray is imperfect in all our

specimens, so that its exact length is doubtful. In B what remains of it is equal in length to the post-orbital part of the skull, but only the distal third is serrated. The serrations in all our specimens are confined to the distal portion, though in young examples they extend to the base of the ray. The upper part of the fin is black.

The pectoral fins have nineteen rays, with the exception of the left pectoral of B, which has only seventeen. The pelvic fins have eight rays, the outer produced into a filament, but in the two specimens there is only one perfect filament (in the left fin of B); it measures 8·6 cm. A furrow is observable in the dorsum at about twice the length of the head from the snout (in B, rather less in A), and probably represents the commencement of the second dorsal fin, but no rays are observable for some distance back. There is no membrane to this fin. The rays of the anal fin are rather long and slender; the membrane extends to the tips. The false caudal fin of specimen A has already been alluded to.

Lateral line.—Parallel to the dorsum in the posterior region. Anteriorly, from a point about two head-lengths from the snout, it rises in a very gentle curve, the

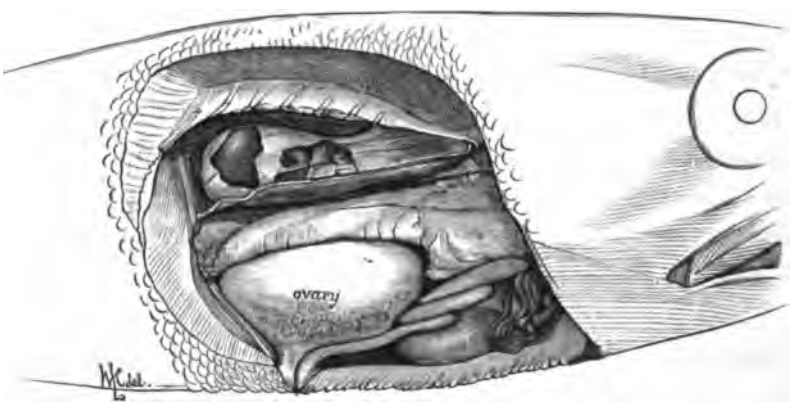


Fig. D.

summit of the curve being about opposite the anus in A, and the centre of the first dorsal fin in B, and in the specimen figured. The curve is not the same on both sides of B.

Colours.—The black of the branchiostegal membrane, distal part of the first dorsal, and of the pectoral, pelvic, and anal fins, is a brownish black, as opposed to the bluish black met with in *M. æqualis*.

Visceral Anatomy.—On opening the abdominal cavity the peritoneum is seen to be thickly speckled with black pigment-cells giving a grey colour to the membrane. The specimen figured was found to be a nearly ripe female, 28¼ inches in length. The ovaries are situated immediately above the vent, closely applied to each other by flattened inner surfaces, joined together inferiorly before the commencement of the single oviduct. Each ovary is rounded and bulging on

the outer surface, and resembles, therefore, the condition seen in many chestnuts which are on the one side convex, on the other flat. Both ovaries taken together have about the capacity of a hen's egg. The ovarian wall is thick and opaque, although near the commencement of the oviduct the pressure of the eggs from within produces a somewhat granulated appearance. The eggs are small and very numerous. After preservation in spirit they exhibit a yellowish red colour. In the fresh condition they measured about 1·25 to 4·31 mm.,* and were therefore not quite ripe, since Collett found ova of 2 mm. in an example of this species.

Owing to the swollen condition of the ovaries, the rectum has assumed a much more horizontal inclination than is described in *M. lævis* and *M. cælorhynchus*. The arrangement of the alimentary tract shows no peculiarity worthy of note.

The liver does not exhibit the one-sided condition seen in *M. lævis*. In the species under consideration there are two large lobes, of equal size, lying side-by-side in a similar manner to the condition already described in the case of the ovaries. The lobes extend the entire length of the upper portion of the abdominal cavity, curving over, and providing a large concavity for the superior surfaces of the ovaries. The air-bladder is again somewhat peculiar. It is almond-shaped, the narrow end being placed anteriorly. When a lateral opening is made, it is seen to be roughly divided into an anterior, middle, and posterior portions, and to be lined with a loose silvery-looking membrane which becomes convoluted and spongy in the anterior portion. An imperfect septum divides the middle from the posterior portion. The middle portion contains a complicated mass of rete mirabile; the anterior and posterior portions are simple and sac-like. There is no pneumatic duct.

The kidneys are so thin and insignificant above the bladder as almost to escape detection. In front of the bladder, however, where the solid kidney becomes divided, as in the other species of Macruri examined, the branches can be followed into the region of the head, where they exhibit pronounced renal or pronephric characteristics. This head-kidney has every appearance of being perfectly functional. Numerous uriniferous tubules can readily be detected in any section of it placed under the microscope, and a large ureter, which, on opening the abdominal cavity, is readily seen passing downwards posterior to the air-bladder, liver, and ovaries, can be traced forwards to this head-kidney.

The presence of a head-kidney has been noticed in all the species of Macruridæ which have come under our notice. The appearance of functional activity given by the presence of uriniferous tubules and a well-marked ureter is therefore of the

* *Vide* Holt, *supra*, vol. iv., p. 452.

more interest. *Mora mediterranea* (*loc. cit.*) is referred to as possessed of this organ also; and one or two other fishes, not obtained during the Survey Expedition, but known to inhabit considerable depths in the Mediterranean, have been described as exhibiting a persistent pronephros in the same manner—notably the various species of *Fierasfer*,* and *Dactylopterus volitans*†. Amongst pelagic or shore fishes a head-kidney does, in some cases, exist, but, as pointed out by Balfour in 1881, it has become degenerate, and is now functionless. Balfour‡ examined the pike, eel, smelt, and angler in confirmation of his own previous statement. The angler (*Lophius piscatorius*) is generally supposed to possess only a head-kidney, and this organ is certainly functional. Parker,§ however, in supporting Balfour's conclusions, argued that this so-called head-kidney was in reality the true body-kidney shifted forward so as to occupy the position of a head-kidney.

The condition described in the case of Dactylopterus has been considered as pointing rather to the belief that a functional head-kidney as well as body-kidney may exist; because in the developing embryo the segmental duct and pronephros are developed at a much earlier period than the mesonephros, and must be permanently separated from all abdominal viscera before the completion of the mesonephros; and, also because from the manner in which the head kidney is incased in bone, any forward growth of a body-kidney towards this pronephric position is rendered impossible.‖

The condition observed in *Macrurus rupestris* appears to us to strengthen the last argument, and at the same time to indicate that, amongst deep-sea fishes, a persistent and functional head-kidney seems to be much more common than it is amongst fishes inhabiting shallow water.

The conditions of life at great depths of the ocean is known to produce marked modifications on the fauna. In many instances this modification takes the form of degeneracy; but, in others, as in the example under consideration, an ancestral organ appears to be retained in its early condition.

Section I. (*vide*, p. 450)

(*b*.) Mouth inferior; infra-orbital ridge more or less distinct; dorsal spine serrated.

* Emery, C. "Le Specie del Genere Fierasfer nel Golfo di Napoli." Leipzig, 1880.
† Calderwood, W. L. "Proc. Roy. Soc. Edinb.," xvii., 1890.
‡ Balfour, F. M. "Quar. Jour. Mic. Sc.," January, 1882.
§ Parker, W. N. "Brit. Assoc. Reports," 1882, p. 577.
‖ Calderwood, W. L. "Journal Mar. Biol. Assoc.," vol. ii., No. 1 (N.S.), p. 43.

Sub-genus **Macrurus.**

Macrurus æqualis, Günther. (Deep-sea.)

(Pl. XL., figs. 1, 1*a*.)

Macrurus æqualis, . . .	GÜNTHER, "Ann. & Mag. Nat. Hist.," 1878, vol. ii., p. 25.
,, ,, . . .	GÜNTHER, "Challenger," vol. xxii., p. 134, pl. xxxii.
,, ,, . . .	HOLT, "Proc. Roy. Dub. Soc.," vol. vii., p. 122.
Macrurus smiliophorus,* . .	VAILLANT, "Exp. Sci. Trav. Talis. Poiss.," p. 242.

Remarks on the Synonymy.—Dr. Günther, in the "Challenger" Memoir, includes *Macrourus serratus*, Lowe, as a doubtful synonym of *M. æqualis*, and remarks that, the type being lost, it is doubtful whether Lowe's species is identical with *M. æqualis* or with one of the closely allied species of the sub-genus Macrurus. Lowe, however, distinctly described the scales in *M. serratus* as smooth, with radial striations,† a feature which should distinguish the species readily enough from any of the forms suggested by Dr. Günther. The rediscovery, in the Mediterranean, of *M. serratus* by Dr. Giglioli ‡ sets the matter at rest, as, in a courteous letter in answer to our inquiries, the Italian observer informs us that his specimens agree in all important particulars with Lowe's description. The scales are smooth, with slight radial striations, and the outer pelvic ray is produced into a long filament which reaches the twenty-third anal ray. Moreover, the mouth is sub-terminal and very wide, and Dr. Giglioli places the species in the genus (or sub-genus) Coryphænoides.

DIAGNOSIS OF SPECIES. (D. 10–13; § Pelv. 8–9.)—Snout conically projecting beyond the mouth, with rather obtuse and rough upper edge. The cleft of the mouth extends nearly to below the centre of the eye in large examples; further back, the anterior profile being also more oblique, in younger stages. Teeth of

* In the Appendix, p. 386, the author acknowledges the identity of his species, *M. smiliophorus*, with *M. æqualis*, Günther, and refers the specimens described by himself under the latter name to a new species, *M. sublævis*.

† "Proc. Zool. Soc. Lond.," 1843, p. 91.

‡ "Nature," vol. xxv., p. 535.

§ These numbers may be reduced by one, if the very short anterior spine is omitted from the calculation.

outer series visibly stronger than the remainder. Barbel slender, not so long as the eye. The dorsal profile rises rather suddenly towards the anterior dorsal spine, especially in large specimens. The inter-orbital space is flat, or very slightly convex; its width considerably less than the diameter of the eye, which conspicuously exceeds the length of the snout, and is from two-fifths in young examples to one-third of the length of the head in large examples. In small examples the exposed surface of the scales are beset by three principal rows of rather long, slender spinelets, those of the central row the largest, subsidiary rows of smaller spinelets being also present. The number of rows increases with age, and the spinelets become relatively shorter and stouter, until in large specimens the whole of the exposed surface is closely packed by short, conical spinelets, sub-equal in length, and not arranged in definite rows. There are eight scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine nearly as long as the head, armed along its anterior edge with barbs pointing upwards and rather closely set. The second dorsal fin commences at a distance from the first, which is less than the length of the head. The outer pelvic ray usually produced into a short filament reaching beyond the commencement of the anal fin.

Colours.—Anterior and lateral part of head and caudal region dull silvery grey. Trunk deep indigo-blue, darkening ventrally into blue-black, which extends on to the under-surface of the head. Young examples the darkest. Antero-superior part of first dorsal black. The blue colouration gradually disappears in specimens preserved in alcohol.

The above diagnosis being founded upon specimens between 13·5 and 34·5 cm. in length, the terms "large" and "small" must be interpreted accordingly.

Description of Specimens.—Of the seven examples taken during the Survey we select four for description, as illustrative of different stages of development. We are able to add another specimen, also from the West of Ireland, though not taken during the Survey. It is rather larger than any of our own examples, and therefore makes our series the more representative. It will be designated as *X*, the Survey specimens being termed respectively *A*, *B*, *C*, and *D*.

Dimensions.

	X.	*A.*	*B.*	*C.*	*D.*
	cm.	*cm.*	*cm.*	*cm.*	*cm.*
Total length,*	34·5	29·10	19·00	18·00	13·50
Length of head,	5·6	4·75	3·30	2·65	1·90
,, eye,	1·9	1·70	1·30	1·10	·80
,, snout,	1·5	1·05	·85	·65	·50
,, barbel,	1·1	·70	·35	(?)	—
Width of snout,	1·6	1·40	·75?	·75	·65
,, inter-orbital space,	1·2	1·00	·70	·60	·45
,, head,	3·3	2·50	1·70	1·30	1·00
Greatest height of body,	5·6	4·75	2·80	1·90	1·65
,, width ,,	2·5	2·35	1·40	1·25	·85
Tip of snout to mouth,	1·7	1·40	·80	·80	·50
,, 1st dorsal fin,	7·2	5·65	3·90	3·25	2·40
,, 2nd ,,	10·8	9·35	6·10	4·80?	3·50?
,, pelvic fin,	6·5	5·40	3·40	2·90	2·05
Length of outer pelvic ray,	(?)	2·50	1·95	(?)	1·10
Greatest diameter of eye,	1·9	1·80	1·30	1·15	·85
Least ,, ,,	1·9	1·50	1·00	7·50	·60
Tip of snout to vent,	6·5	5·80	4·10	3·10	2·45
Vent to isthmus,	3·1	2·80	1·80	1·60	1·10
Origin of pelvic fin to vent,†	·5	·40†	·25	·20	·15
Vent to origin of anal fin,	1·7	1·45	1·05	·50	·65

Proportions and Conformation.—Owing to the defectiveness of the caudal region in most of the specimens the total length is not of much use in instituting comparisons of their relative sizes. The length of the head forms a better basis, or the distance between the tip of the snout and the commencement of the anal fin. The anus, as we shall see later, is not sufficiently constant in position to enable the pre-anal length to serve as the unit of measurement. Taking either of the dimensions suggested into consideration, it appears that the series is fairly representative of those sizes which fall within its limits.

* In specimens *X* and *A* the caudal region is incomplete; this is also the case in *B*, which, moreover, possessed a false caudal fin. The caudal region appears to be complete in *C* and *D*.

† Measured from insertion of inner ray of pelvic fin to centre of vent.

‡ Position of vent perhaps somewhat distorted by the eversion of the ovaries.

The possession of such a series is the greatest assistance in identification, since the resemblance which each specimen bears to its immediate neighbour bridges over the discrepancy of the extremes. It is especially useful when, as in the present instance, a species has only been known previously from the description of a particular size, since the discoverer cannot be expected to anticipate the conditions in stages which he has never seen, and in attempting to do so, except in the vaguest possible manner, would only be wasting his own time and that of his readers. Hence, a small example of a species of which only the adult stage has been described might well present such differences of proportions, and other characters dependent on age or size, as to run the risk of becoming the type of a new species, ultimately destined to the fate of a synonym. We certainly know, thanks chiefly to Dr. Günther's researches, that certain proportions and characters vary with the size of the individual, as indeed is the case in all fishes, but it is impossible to compute the relations of size to degree of development of such characters with sufficient accuracy to eliminate all risk of confusing nearly allied species. Such must be our excuse for a somewhat tedious discussion of the condition of each example of the series.

In the largest example, *X*, the eye is contained about three times in the length of the head, while in the smallest it occupies only about two-fifths of that dimension. In this case the length of the eye is taken to be the distance between the most anterior and the most posterior point in its circumference. Except in the largest example it is not circular, but longer than high, its greatest actual length being in an oblique direction, parallel to the infra-orbital ridge, while its least diameter is vertical to the course of that structure. The Table of dimensions shows sufficiently that this elongation is a feature which tends to disappear with the growth of the individual, and we need only add that the flattening of the inferior margin of the eye in the specimens forming the middle of the series replaces a slight concavity in the smallest of all, which seems to indicate a very late persistence of the choroidal notch in this species.

That the alteration in the proportion borne by the antero-posterior diameter of the eye to the length of the head is gradual, and extending, *pari passu*, with the growth of the fish, is shown very clearly when the first-named dimension is converted into a decimal of the other, the result being, in *X* ·33, in *A* ·35, in *B* ·39 in *C* ·41, and in *D* ·42. The growth of the snout, as compared with that of the eye, appears to be more commensurate, the former maintaining a dimension varying from three- to four-fifths of the latter throughout the series. It is certainly largest in the largest specimen, but the proportionate diminution shown by the second specimen is not regularly maintained by the remainder, the figures of the snout in terms of the eye being as follows: *X* ·78, *A* ·61, *B* ·65, *C* 59, *D* ·62. The length of the snout in *X*, therefore, is probably partly illustrative of individual variation, and not solely of developmental change.

But although the relative length of the snout does not appear to be much affected by the growth of the fish, our series shows a gradual transition in the profile of the same organ, and of other parts of the head related thereto. Before discussing this it is necessary to refer briefly to the general appearance of this region. A glance at the figure shows that the strong infra-orbital ridge is continuous with another ridge extending from the anterior extremity of the nasal bones to the apex of the snout, and thus somewhat sharply dividing the pre-orbital region into a dorsal and ventral area. It may be convenient to term this last the "rostral" ridge; and on examining the head from above it is seen that the rostral ridges meet at the apex of the snout in such a manner as to form practically a right angle, while each ridge makes a distinctly obtuse angle with the anterior part of the infra-orbital ridge of its own side. The direction of the ridges is here considered as straight, though as a matter of fact the infra-orbital ridge is somewhat convex, and the rostral ridge is, in preserved specimens at any rate, frequently concave. As such it is shown in Günther's excellent figure (*op. cit.*, pl. xxxii., fig. *c*); but it is evident from our series that the ridge may run in a straight, or even in a slightly convex, direction between the tips of the nasal and ethmoid bones; and we are strongly inclined to believe that the concavity, when it exists, is due to the collapsing of the underlying muciferous cavities by the action of the preserving fluid.

Returning to the lateral point of view, the figure (which represents the specimen here designated as *A*) shows that the obliquely upward direction of the infra-orbital ridge is continued by the dorsal ridge, and consequently the tip of the snout is above the level of the tip of the nasal bones. Such is also the case in the figure of Günther's type specimen, which is about the same size as *A*, and it is also the case, and to a rather greater extent, in *X*. However, as we turn to the smaller examples, we find that in each the level of the snout is slightly more depressed, the rostral ridge assuming a direction more nearly parallel to that of the long axis of the head and body, until, in *D*, the tip of the snout is actually rather lower than the end of the nasal bones. Very small specimens of *M. æqualis* therefore exhibit, in the profile of the snout, a closer resemblance to *M. sclerorhynchus* * than to adults of their own species, though agreeing with the latter in the length of the organ. The mouth maintaining much the same relative distance from the tip of the snout throughout the series, and at the same time being restricted to about the same horizontal plane, it follows that the anterior profile (ventral to the snout) becomes gradually more oblique as the size diminishes and the mouth is displaced further backwards. Thus, while in *X* and *A* the angle of the jaw barely reaches the level of the centre of the eye, in *D* it extends nearly to the

* *Cf.* Günther, *op. cit.*, pl. xxxii., wherein adults of both species are figured.

hind wall of the orbit. Here again we find the young exhibiting a closer resemblance to adults of another species (in this case *M. Bairdii*) than to their own, though the gradual transition of the character throughout the series leaves their specific identity in no doubt. In yet another character we find the young presenting a close resemblance to adults of other species, viz. in the direction of the posterior margin of the pre-operculum. In the larger specimens of *M. æqualis* (*cf.* fig. 1, or Günther, *loc. cit.*, fig. C), this scute is almost vertical in its posterior outline, whereas in *M. sclerorhynchus* and *M. Bairdii* it is decidedly oblique. It is equally oblique in our specimen *D*, but becomes more and more upright as the size increases. It is a feature which is, of course, connected with, and directly dependent on, the forward rotation of the mouth, in the greater extent of which *M. æqualis* may be said to exhibit a less degree of specialisation than the other two species.

The proportion borne by the head and trunk to the total length is rendered in this, as in many other species of Macrurus, of small importance, on account of the frequent mutilation of the extreme caudal region, especially in large examples. Both *X* and *A* (*cf.* fig. 1) seem to have lost some part of the end of the tail, as the latter terminates rather bluntly, but the proportions are much the same (head in total length, *X* $6\frac{1}{8}$, *A* $6\frac{1}{10}$ ca.) in both examples, and may be representative of the condition usual in adults. Specimen *B* is obviously mutilated, and exhibits the simulation of a caudal fin so well known in this genus; but *C* and *D* appear to be perfect, the tail terminating in a long, slender filament; the length of the head, however, is contained in the total length not quite six times in *C*, and over seven times in *D*, so that either the variation in this feature is considerable, or the caudal filament in one specimen is in reality imperfect.

Dr. Günther has described in *M. rudis*, a species stated to be very closely allied to that now under consideration, a regular developmental change in the position of the vent, from a point near the origin of the pelvic fins in the young to one much nearer the commencement of the anal fin in old examples. It follows that the proportion borne by the distance between the vent and isthmus to the length of the head increases with the growth of the fish.* No evidence of a similar developmental migration in *M. æqualis* is afforded by our series; but it does appear that the vent is subject to a rather extraordinary irregularity in position, though its relationships to the pelvic fins are practically constant. The distance between the vent and the isthmus in terms of the length of the head is for *X* ·55, *A* ·58, *B* ·54, *C* ·60, and *D* ·53. The first dimension therefore seems to vary from about five- to six-tenths of the last, without regard to the size of the individual.

A character given by Dr. Günther, in his description of the "Challenger"

* *Op. cit.*, p. 132.

specimens, is the rather sudden rise of the dorsal profile from behind the head to the anterior dorsal fin. Our figure shows that this is very well marked in specimen *A*, and it is equally conspicuous in *X*. In both these, the greatest height of the body thus attained at the level of the anterior dorsal ray is equal to the length of the head; but in our smaller examples the rise of the profile becomes less abrupt, and the greatest height of the body relatively less. In the specimen *C* the height is perhaps even less than is usual in examples of the same size, since it is relatively less than in *D*.

Fins.—The short stout spine, which exists at the commencement of the first dorsal in all Macruri, is especially well-developed in Günther's sub-genus Macrurus, and always projects through the skin. Hence that author speaks of the barbs as existing on the "*second*" ray, and apparently counts the anterior spine in enumerating the formula, though he omits it from all consideration in Coryphænoides, and locates the barbs on the "first" ray in that sub-genus. The "Challenger" type specimens of *M. æqualis* are therefore credited with twelve rays in this fin. Adopting the same method of reckoning we find a variation of from 10 to 13 rays in the seven West of Ireland specimens, but 12 is the number which occurs most frequently; and the last few rays are in all cases so minute and rudimentary that a variation in their number presents no difficulty in the way of specific identity. The barbed ray is imperfect in all the specimens, but appears to have had about the same relative length throughout the series, viz. one not quite equal to that of the head. The barbs are absent from the extreme basal region of the ray, as in figure 1, in which respect our specimens appear to differ from the type, if the latter is represented* with absolute accuracy in this rather unimportant detail. The point at which the second dorsal commences is indistinct in the smaller specimens, but appears to be much the same as in the larger, viz. at a distance from the snout somewhat less than half the length of the head. So far as the membrane of the anal fin is concerned, our figure is a restoration, as very little of it is left in the actual specimen, though the rays, about 104 in number, are in a fair state of preservation. In specimen *B*, which, as has already been stated, exhibits a simulated caudal fin, the rays of this structure are, as usual, considerably longer than those of the adjacent part of the anal fin.

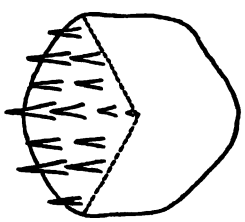
It is evident that all the Irish examples originally possessed an outer pelvic ray produced into a filament, though this is now imperfect on one side or the other in most examples; and, in the rest, on both sides. When perfect it extends beyond the origin of the few anterior anal rays. In the type specimens this ray was "not, or but slightly produced,†" a description which the frequent imperfection of the slender filamentous portion renders quite compatible with the condition in the Irish examples. A more serious difficulty is the discrepancy in the number

* "Chall.," vol. xxii., pl. xxxii., fig. C. † Günther, *op. cit.*, p. 135.

of the pelvic rays, viz. eight in the Irish examples, and nine in the type. However, the specimens which Vaillant has referred to in this species are also stated to possess eight rays, at least that is the number given in the diagnosis of his species, *M. smiliophorus*,* acknowledged in the index to be synonymous with *M. æqualis* (Günthur); and, Dr. Günthur, who has been kind enough to examine our Survey specimens, considers our identification correct. A parallel is found in some other species of Macrurus, though the number of the pelvic rays is usually constant in Gadoids; and it is rather remarkable that the type specimens should exhibit that condition which appears to be the least common in the species.

Scales.—The type specimens, eight and nine inches long, are described as having scales "equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, but arranged in from eight to twelve series, the middle series being not more prominent than the others (as in the case in *Macrurus sclerorhynchus*). The entire margin of the scale is spinous." The figure below represents the spinelets as comparatively short and rather stout, but not entirely covering the exposed surface of the scale.

In our series we find a gradual transition in the character of the spinelets. In the smallest example, *D*, the condition differs widely from that of the types.



There are three rows of relatively very large spinelets, of which the central row is usually slightly the strongest. Two rows of much smaller spinelets occur between the larger ones, and single spinelets at the dorsal and ventral extremities of the exposed part of the margin represent the formation of the other two rows, bringing the total number up to seven. The interval between each row is considerable, and thus a great part of the exposed surface and its margin is left destitute of spinelets, though the last of every row projects beyond the margin. In the next example, *C*, there are, unfortunately, very few scales left on the body; the usual number of rows appears to be about eight, of which only three are regular. As in *D*, the central row is the stronger; but all the spinelets of the three principal rows are relatively slightly smaller than in *D*. But, for the fact that the posterior spinelets of most of the rows project beyond the margin, the condition would be practically identical with that of *M. sclerorhyncus*† when half as large again as the example now before us; but it is reasonable to suppose that in smaller stages of that species the spinelets of the principal row are relatively larger, and the subsidiary rows fewer than in the adult, or in specimens of *M. æqualis* which agree with them in size.

Specimen *B*, allowing for the deficiency of the caudal region, is considerably larger than *C*, and we accordingly find a proportionate advance in the spinulation

* Vaillant.

† *Cf.* Günther, *op. cit.*, p. 134, pl. xxxii., fig. A.

along the lines indicated by the comparison of *C* and *D*. The spinelets have increased in numbers, so that they practically cover the whole of the exposed surface; they are not very regularly arranged, but it is possible to make out about twelve rows. They have thus reached the condition in the "Challenger" type specimens (with the smaller of which *B* agrees pretty closely in size) with the exception that the median spinelets (or at any rate the posterior spinelet of the median row) are usually a little longer that the rest. The identity of the two other principal rows is practically lost; but rather large spinelets, perhaps belonging to these rows, occur dorsally and ventrally. All the spinelets are distinctly less elongated, and more conical, than in the smaller examples. A scale of specimen *a* is shown in the figure 1 *a*, Plate XL., and exhibits a further advance along the same lines. The spinelets have so increased in number that they are closely packed over the whole of the exposed surface, and it is no longer possible to arrange them in rows. About twenty to twenty-two spinelets may be counted along the anterior border of the exposed region; and although they are not all of the same size, all are short and conical, and not larger in the median row than elsewhere. Moreover, the bluntness of many spinelets seems to indicate that the limit of their growth has been reached. There is a very close approach to the condition in *M. nasutus* and *M. serrulatus*,* especially the latter; and since the smallest known example of that species is thirteen inches long, it seems probable that it would be very hard to distinguish smaller specimens from *M. æqualis* by the scales alone. In *M. nasutus* the spinelets appear to be considerably longer. Dr. Günther mentions the close resemblance between the species before us and young examples of *M. rudis*, but since the spinelets are shown as distinctly elongated in a large example of that species, we should think that the spinulation of young stages must so far differ from that of *M. æqualis* at the same size as to furnish a distinctive character in addition to those enumerated by the author named.

Colouration.—Much alike in all specimens. Anterior and lateral parts of head and posterior region of trunk and tail, dull silvery grey. Anterior part of body deep indigo-blue, continued along the top of the head to the inter-orbital region, where it shades off into the grey. Posteriorly the blue shades off in specimen *a* along an oblique line running from the hinder end of the first dorsal to about the tenth ray of the anal fin. In the smaller specimens the posterior limit of the colour is further back and more vertical, the line of demarcation being at a distance from the snout about twice and a-half the length of the head. Ventrally the blue deepens into a blue-black, which is the colour of the belly, edges of the jaws and under-surface of the head, with the exception of the barbel, which is devoid of dark pigment. The pectoral fins are very dark blue; the branchiostegal membrane and pelvic fins deep black; the anterior part of the anal deep indigo-blue;

* *Cf.* Günther, *op. cit.*, pp. 132, 133.

and the antero-superior part of the first dorsal black. The posterior outlines of the bones of the gill-cover, and the margin of the orbit, and of the oval groove are marked by lines of deep blue. The iris is black; the mouth closely speckled with dark pigment.

The action of alcohol tends to eliminate the blue colour; hence the specimen *X*, which has been longest in spirits, shows less blue than the rest. The same reason, probably, accounts for the absence of any mention of a blue colouration in the description of the type specimens, since these were only known to Dr. Günther in the preserved condition.

Locality and Distribution.—The Survey examples are seven in number, trawled in one haul at 500 fathoms, 54 miles off Achill Head, on the 10th July, 1890. The species was not previously known from British waters. Dr. Günther's type specimens, two in number, were taken by the "Challenger" at 600 fathoms, off the coast of Portugal. Vaillant obtained sixteen examples, from the Bay of Biscay, the coasts of Morocco and Soudan, and the Canary Islands, at depths of from 248 to 714 fathoms.

SECTION III. (*Vide* p. 450.)

Intermaxillary teeth, uni- or bi-serial; mandibular teeth, uni-serial.

A. Dorsal spine smooth.

Sub-genus **Malacocephalus.**

Macrurus lævis, Lowe. (Deep-sea.)

(Pl. XL., figs. 3 and 3*a*.)

Macrurus lævis, ... LOWE, "Proc. Zool. Soc. Lond.," 1843, p. 92.
Malacocephalus lævis, . . . GÜNTHER, "Cat. Fish. Brit. Mus.," vol. iv., p. 397.
,, ,, . . . LÜTKEN, "Vid. Meddel. Nat. Foren. Kjoben.," 1872, p. 1.
Macrurus lævis, ... GÜNTHER, "Chall.," vol. xxii., p. 148, pl. xxxix. B.
,, ,, ... GÜNTHER, "Ann. Mag. Nat. Hist.," vol. iv., 1889, p. 418.
,, ,, ... BOURNE, "Journ. M.B.A.," N.S., vol. i., No. 3, p. 311.
,, ,, ... ALCOCK, "Ann. Mag. Nat. Hist.," 1889, p. 391.
,, ,, ... HOLT, "Proc. Roy. Dub. Soc.," and vol. vii., pt. 3, p. 220.

DIAGNOSIS OF SPECIES. (D. 11–13; P. 16–18; V. 8–9.)—Head compressed,

with vertical sides; snout obtusely conical, slightly projecting beyond mouth, the cleft of which is oblique, extending to the level of middle of eye. The distance from tip of snout to anterior margin of orbit equal to distance between the two anterior neres. In specimens of all sizes the greatest diameter of eye is equal to the breadth of the interorbital space. Distance from snout to base of first dorsal fin-ray equal to twice the extreme breadth of head. Teeth of upper jaw bi-serial, a toothless space occurring in the centre of the jaw; the inner series has the appearance of a villiform band. Teeth of the lower jaw uni-serial, separate. Barbel shorter than eye. Distance from tip of snout to median toothless space of upper jaw equal to distance from snout to posterior neres. From toothless space to isthmus equal to distance from isthmus to vent in specimens of thirteen or fourteen inches in length.

Scales (fig. 3*a*) very small, much deeper than long, covered with short, minute spinelets. In small specimens, the spinelets are few in number and large in proportion to the size of the scale.

Lower margin of preoperculum not serrated; anterior dorsal spine smooth.

A triangular, scaleless, and black-coloured depression is situated between the bases of the ventral fins. Immediately behind this, a similar depression of an oval shape occurs, and behind this oval depression lies the vent.

Locality and Distribution.—Twenty-five examples of this species, ranging in size from 25·5 to 54·5 cm. (10 to 21¼ inches), were trawled during the Survey. One was taken in 200 fathoms, 50 miles off Bolus Head, Co. Kerry, and the remainder in water ranging from 144 to 220 fathoms, 26 to 40 miles off Achill Head, Co. Mayo.

The species appears to be more widely distributed than any of its congeners, since it occurs both in the Atlantic and Pacific Oceans.

The Atlantic specimens have been procured from the coasts of Norway (Malm)*, Denmark (Lütken), Madeira (Lowe), Pernambuco (Günther), and the west coast of Ireland; while Pacific specimens were obtained from the Andaman Sea (Alcock).

Although the species is not mentioned amongst the results of the "Travailleur" and "Talisman" expeditions, nor from high latitudes in the records of the Norwegian North Atlantic expedition, it appears to be abundant on the slopes of the continental plateau to the west of Ireland, where, before the specimens now described were procured, it had been obtained by the "Flying Fox" (Günther) and "Research" (Bourne).

So far as the records of capture show us, the vertical range of this species is

* "Göteb. o. Bohüsl. Faun.," p. 503. A single specimen cast up on the shore. Lütken (*op. cit.*) records that the single Danish specimen was also cast up on the Northern coast of Jutland.

only from 154 to 350 fathoms. It is probable, therefore, that it is one of the lea s abysmal of the Macruri.

Dimensions and Variation.—Owing to the large number of specimens procured, we are able to give two Tables, showing in the first the measurements of four carefully selected specimens of different progressive sizes, and in the second the measurements of four specimens of the same size, with a view of showing the variation which may occur. In the latter table the specimens may be roughly said to measure one foot in length, the actual variation in total length between the four specimens being half an inch.

I.—*Table of measurements, given in centimetres, of four specimens of M. lævis, named A, B, C, and D.*

	A.	*B.*	*C.*	*D.*
Total length,	25·5	30·5	36·8	43·0
Length of head,	4·0	4·8	5·7	6·7
Length of snout,	1·1	1·3	1·7	1·9
Width of snout,	1·5	1·5	2·0	2·3
Width of interorbital space,	1·4	1·8	2·0	2·1
Width of head,	2·1	2·5	3·1	4·0
Greatest height of body,	3·3	4·0	4·9	6·0
Greatest width of body,	1·7	1·9	2·5	3·3
Tip of snout to mouth,	·9	1·0	1·3	1·6
,, to 1st dorsal fin-ray,	4·4	5·4	6·4	7·6
,, to 1st fin of 2nd dorsal,	7·4	9·0	11·2	12·9
,, to base of pelvic fin,	4·3	4·9	6·3	7·4
Greatest diameter of eye,	1·4	1·7	1·9	2·2
Least diameter of eye,	1·3	1·4	1·7	1·9
Distance from vent to isthmus,	1·9	2·4	3·2	3·7

II.—*Table of measurements, given in centimetres, showing the variation between four specimens approximately the same size, named E, E^1, E^2, and E^3.*

	E.	E^1.	E^2.	E^3.
Total length,	30·4	30·0	29·0	30·0
Length of head,	4·9	4·6	4·8	4·6
Length of snout,	1·3	1·3	1·2	1·3
Width of interorbital space,	1·5	1·5	1·5	1·5
Width of head,	2·9	2·6	2·6	2·6
Greatest height of body,	4·2	4·2	4·2	4·2
Tip of snout to mouth,	1·1	1·1	1·1	1·1
,, to 1st dorsal fin-ray,	5·2	5·2	5·4	5·4
,, to 1st ray of 2nd dorsal,	8·8	8·5	8·9	8·4
,, to base of pelvic,	5·9	4·9	4·9	4·7
Greatest diameter of eye,	1·8	1·6	1·7	1·7
Vent to isthmus,	2·9	2·4	2·2	2·6
Isthmus to snout,	4·3	3·5	3·3	3·6
Vent to tip of lower jaw,	5·8	4·7	4·7	4·8

The tail in each specimen seemed to be complete, so that we believe the measurements of total length to be accurate. It will be observed that specimen *E* is longer, by 4 mm., than E^1 and E^3, and by 5 mm. than E^2. This may account for a proportion of the greater measurements found in the first column, but not for the great increase which is found in the measurements of "Tip of snout to base of pelvic fin," "Isthmus to snout," or "Vent to tip of lower jaw." These three measurements show that specimen *E* has a much greater distance between the various points on the ventral surface of the body; whereas the measurements on the dorsum, such, for instance, as "Tip of snout to 1st dorsal fin-ray," show that a proportionate elongation does not take place, and that the distance may even be shorter.

The width of the interorbital space remains constant, as does the distance from tip of snout to the toothless space in the upper jaw, and the measurement of the greatest height of the body.

A variation in the general outline of the body and head exists amongst the Macruri as amongst other groups of fishes. The profile may be more boldly convex in the frontal and prefrontal regions.

The greatest actual variation in point-to-point measurement, however, is certainly found in the relative positions of the vent, isthmus, and pelvic fins; and this variation has no such developmental significance as has been demonstrated by Günther in the case of *M. serrulatus* (*op. cit.*, Pl. xxx., fig. 2 *a*).

Fins.—An examination of a number of specimens shows a greater amount of variation in this respect than seems previously to have been recognised. The details of six specimens are here given:—

	1st Dorsal.	Pect.	Vent.
A, ...	11	16	9
B, ...	13	18	8
C, ...	13	16	9
D, ...	11	18	8
E, ...	12	17	8
F, ...	12	17	—

We have not found a specimen with as many as 14 rays in the first dorsal, as set down by Günther in his "Challenger" Report; and our formulæ, in introducing the numbers 12 and 16 for the dorsal and pectoral fins, respectively, seems to draw a certain additional resemblance to the formula given by Günther for *Macrurus italicus*, a form which that author shows so closely resembles *lævis* that, but for the condition of the teeth, the two would have been thrown together.

The single specimen of *M. italicus* procured by the "Challenger" was only 5¼ inches in length. Giglioli, the founder of the species, seems also to have had only one small specimen.* On the other hand we do not find in *lævis* more than 9 rays in the ventral fin.

Scales.—The scales of our smallest specimens are somewhat irregularly arranged, are very deciduous, and bear relatively long spinelets arranged in two or three very irregular rows. The condition in the adult is quite distinct (fig. 3*a*.) The scales of the young examples are apparently very similar to those described for *M. italicus*.

Size.—So far as we know, the largest recorded size is that of our largest specimen—21½ inches or 54·5 cm.

Abdominal Viscera, &c.—In the specimens examined the viscera seemed remarkably small, a considerable space remaining even after allowing for an unusual amount of shrinkage. The black scaleless depressions already mentioned have on their inner surfaces strong muscular attachments for the rectum and the generative ducts. The rectum comes almost directly downwards, while the generative ducts pass forwards and downwards from the posterior extremity of the abdominal cavity where the curved reproductive organs are situated. Both are borne by a

* "Challenger Reports," vol. xxii., p. 141.

large and conspicuous mesentery. On the left side a long lobe of liver extends almost the entire length of the cavity bending into a median position for the second half of its course. On the right side the liver forms only a small leaf-like process projecting from the basal portion, but on this side of the median mesentery a fold of the intestine passes backwards. The stomach shows a well-defined fundus, the duodenum springing from the middle of the inferior surface. The pyloric coeca are very numerous; a delicate air-bladder is present. It is almond-shaped, and is covered on its under-surface by black peritoneum. On opening the bladder a circular aperture bounded by a sphincter muscle is at once visible in the centre of the median dorsal surface. This aperture has no duct in connection with it, but is merely a perforation of the upper surface. At the same time it is noticeable that the bladder is very loosely held in its position by membranes from the dorsal wall, which form a secondary cavity above and to each side of the bladder. This inclosed part of the body cavity, therefore, communicates freely with the air-bladder, and is probably utilized when the gases of the bladder increase in volume. At the anterior end, there are two rete mirabile of considerable size which may provide for such an increase; and the space found in the abdominal cavity proper, owing to the viscera not entirely filling the cavity, as already mentioned, seems also to indicate that a great increase does take place. Some such provision might be necessary if the creature has the habit of frequenting water of widely different pressures during short intervals of time, or has a much greater vertical range than the records of its capture have yet shown.

The kidneys show an arrangement not unlike that seen in *Cyclopterus*. There is a single-body kidney which divides anteriorly (at a level, in this case, of the eleventh vetebra) into two branches, which pass forwards and outwards to the region of the ex-occipitals and there forming thickened masses, may probably represent persistent head-kidneys.* Unlike *Cyclopterus* the single-body kidney is extended backwards also. It passes down the hæmal arches of the tail to the level of the thirty-eighth vertebra. The entire organ may be said to stretch half the length of the body and tail of the fish.

In the skull, the muciferous cavities extend widely over the surface, immediately beneath the skin. Behind the eye, the opercular muscles occupy their normal position, but the skull on all other parts of its surface is soft to the touch through the presence of the cavities. The conical snout seems to form the central point from which the various channels diverge. The two cavities which occupy the interorbital space pass backwards from the region of the frontals to the level of the posterior margin of the operculum. Above the maxillæ, also, cavities extend which send slender branches upwards behind the eyes, so as almost to join the cavities of the frontal region, and thus encircle the orbits.

* As in *Cyclopterus* and *Anguilla*, this head kidney appears to be degenerate and functionless in the adult.

Fam.—**PLEURONECTIDÆ.**

Genus **Hippoglossus**, Cuvier.

Hippoglossus vulgaris, Fleming. The Halibut. (Deep-sea.)

Only three specimens were obtained during the Survey, the depth in no case exceeding 35 fathoms. The species, however, is by no means confined to littoral waters, since it appears that, on the fishing grounds of Newfoundland, the greater number of fish are now taken at a depth of from 100 to 200 fathoms. Halibut are also regularly taken on the Faroë grounds at depths exceeding 100 fathoms.

Genus **Hippoglossoides**, Gottsche.

Hippoglossoides platessoides, Fabricius. The Long Rough Dab. (Deep-sea.)

Hippoglossoides platessoides, .	Collett, "Norw. N. Atlant. Exp. Fish.," p. 144.
,, ,, .	Goode, "Proc. U. S. Nat. Mus.," iii., p. 471.
,, ,, .	Holt, "Trans. Roy. Dub. Soc.," N.S., v., p. 57.
,, *limandoides*, .	Holt, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 319, 403, 442.

The younger stages of this species have been dealt with by one of us at considerable length in a former number of these "Transactions," while details as to locality and depth of all specimens captured are given in the "Scientific Proceedings" (Nos. XXVIII. and XXIX.). The Papers last referred to having been originally prepared for the Annual Report to the Council of the Society, it was thought to be for the general convenience to make use of the nomenclature followed by Day in his "Fishes of Great Britain." Accordingly the species now under consideration appears therein under the name of *H. limandoides*, although Collett had already shown most clearly that the Palæactic and European variety (*H. limandoides*, Bloch *et auct. plur.*) is not specifically distinct from the Nearctic type bearing the older name of *H. platessoides*.

Without entering at length into the very elaborate and convincing discussion given by the Norwegian author, we may point out that two specimens in the Survey collection fully bear out his contention that the Nearctic and Palæarctic forms are not to be distinguished by their proportions. The distinction most apparent in the diagnoses of earlier writers is found in the relative height of the body, which is usually somewhat the greater in the Nearctic examples. In the same haul of the trawl, however, in Donegal Bay, we obtained two specimens of

nearly the same total length, which differed most markedly from each other in height. They are shown in the accompanying figures *E* and *F*, which are out lined from photographs. We subjoin the dimensions (after preservation in

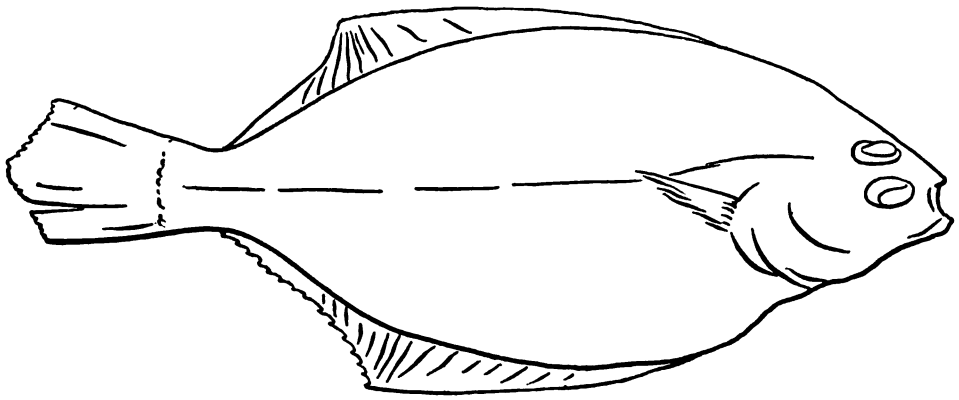


FIG. *E.*

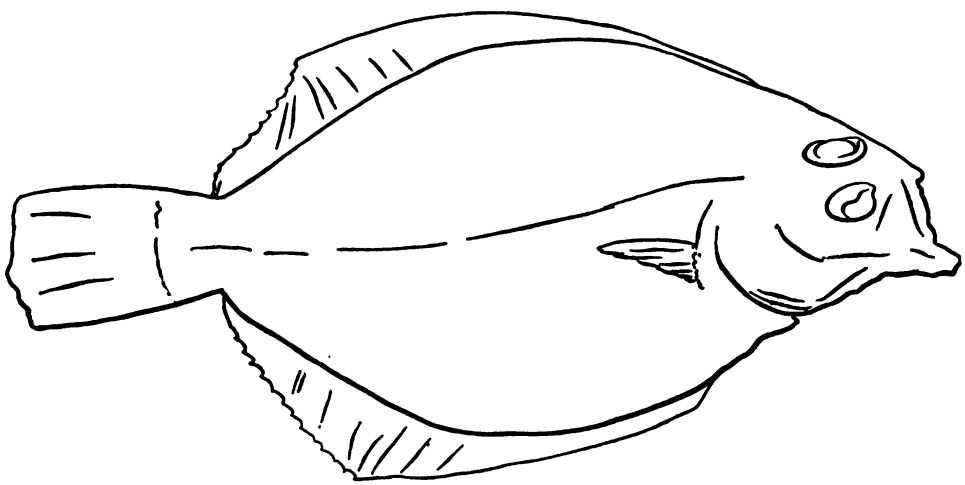


FIG. *F.*

Two specimens of *Hippoglossoides platessoides* taken in Donegal Bay, showing difference in height of body.

alcohol), and of the others at our disposal, which most nearly approach them in size:—

—	Total Length.	Total Length without Caudal Fin.	Greatest Height of Body.	Length of Head.	Length of Eye.*
E, . . .	30·0 cm.	25·0 cm.	10·40 cm.	6·80 cm.	1·30 cm.
F, . . .	29·7	24·5	13·00	7·75	1·40
X, . . .	22·8	19·3	7·20	4·60	1·12
Z, . . .	22·6	18·6	6·65	4·56	1·15

* It may be remarked that, in large examples, the upper eye is slightly posterior to the lower one, and not at the same level, as stated in the diagnoses of several authors.

E, *F*, and *Z* are from Donegal Bay, while *X* is from the east coast of Scotland, and all four examples are females. It will be seen at once that *F* is much higher than *E*, while *X* and *Z* agree well enough with *F* in this respect. *E*, *X*, and *Z* in fact represent the ordinary British type, while *F* is abnormally elevated.

To compare *E* and *F* more closely, it must be remarked that, since both specimens died with their mouths widely opened, the length of the head cannot be very exactly ascertained, though it is evident that the head is considerably the larger in *F*. The distance from the point where the lateral line reaches the operculum and the end of the caudal peduncle is in *E* 19·4, in *F* 18·1, so that the length and height of body, without head and caudal fin, stand thus—*E* 19·4 × 10·4, *F* 18·1 × 13. The greatest thickness of the body is 1·6 cm. in *E*, and 2·35 cm. in *F*. The latter is therefore, in all respects, the more massive example, as appears further from the weights—*E* 5¼ oz., *F* 8½ oz.*

The length of the upper jaw is in *E* 2·35 cm., in *F* 2·7 cm.; that of the lower jaw, from the symphysis to the angular, in *E* 2·7, in *F* 3·1. The height of the caudal peduncle is in *E* 2·3, and *F* 2·65 cm.

In *E* 89 rows of scales cross the lateral line, in *F* 87 rows, and the fin-ray formulæ of the four examples are:—

	A.	*D.*
E, ...	82	61
F, ...	85	66
X, ...	87	70
Z, ...	80	61

The difference between *F* and the other specimens thus rests practically on its greater height. There is no indication of structural malformation, unless a very slight irregularity in the curve of the lateral line on the blind side can be cited as such. The dentition is the same in all the specimens, and there can be no doubt that they all belong to the same species.

Collett remarks, with justice, that the depth increases with the growth of the individual, and it may be that *F* is an old example, as the appearance of its teeth seems to indicate, which, while for some reason stunted in length of body, has continued to increase in height and other dimensions. The conclusion of that author that *H. limandoides* (Bloch) is the southern branch of *H. platessoides* (Fabr.), receives considerable support from the examination of northern and southern examples of other flat fish. Apart from the question of fin-ray formula, it is apparent, on comparing specimens of *Pl. platessa* and *Pl. limanda* from Iceland with those obtained from our own seas, that these species attain, in the northern region, a relative depth of body very much greater than their southern brethren,

* These weights were taken after the specimens, which were preserved at the same time, had been about eighteen months in the same vessel of spirits.

though, as usual, there is great variation in this respect within the limits of either locality.

As regards its distribution, the long rough dab appears to be strictly a Northern species. In the Old Hemisphere it ranges from Spitzbergen to the English Channel, and in the New from Greenland to the New England States, while Collett suspects that it exists also throughout the Arctic Ocean. It appears to attain its largest size within the more northern parts of its range; Collett notes that one of Fabricius' types, from Greenland, measures 45.1 cm., while we have seen examples from Iceland which far exceeded in size any that are obtained in British waters. The species was taken during the Norwegian North Atlantic Expedition at a maximum depth of 223 fathoms, and it has also been found in deep water on the American coast (Goode). It was not taken during the Survey at any depth exceeding 80, or less than 25, fathoms. It is much commoner on the eastern than on the western coasts of Great Britain, and is very abundant in certain parts of the North Sea. Within the latter area it occurs, as might be supposed, in comparatively shallow water, and has been taken by one of us in the Humber, by the other in the estuary of the Forth, although it can by no means be regarded as an estuarine form.

Genus **Rhombus**, Cuvier.

Rhombus megastoma, Donovan. The Sail Fluke or Megrim.* (Deep-sea.)

Arnoglossus megastoma,	. .	VALLIANT, "Exp. Sci. Trav. et Talism. Poiss.," p. 188.
,,	,, . .	HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 122, 219, 444.
,,	,, . .	HOLT, "Trans. Roy. Dub. Soc.," N.S., v., p. 71.

The large size of the eyes, and, as compared with the more familiar of its congeners, the comparative slenderness of the skeletal structures, suggest a somewhat bathybial habitat for the species before us, while, on reference to known facts, it is matter of common knowledge that it is found for the most part in rather deeper water than the majority of British flat fishes. So far as the west coast is concerned, this view is fully supported by the experience of the Survey, of which details have already been given (*cf.* "Sci. Proc." p. 444). We need only recapitulate that by far the greater number of sail flukes taken came from

* The usual name in Ireland and Scotland is "Witch," but the fish is often sold as a "White Sole," probably with a view to enhancing its value, since *Pl. cynoglossus*, the true "White Sole," is considered a better fish for the table.

more than 45 fathoms, while no less than 63 occurred below the 100 fathom line, viz. 8 at 220, 47 at 154, and 9 between 115 and 127 fathoms. We have also evidence that the parents spawn and that the young are reared at considerable depths, since ripe females were taken exclusively at 153, 154, and 220 fathoms,* while the very young examples were most abundant between 70 and 80 fathoms—the greatest depth at which it was possible to work a fine-meshed net suitable for their capture.

The species has been described with sufficient accuracy by Day, but it may be remarked that the specimen from which he seems to have taken both his diagnosis and his drawing must have been slightly abnormal in so far as concerns the curved portion of the lateral line. This is described, and illustrated, as "almost semi-circular," whereas an almost rectangular condition is usual. Variation in the curve, however, occurs no doubt in this, as in other species of the genus,† and we are far from impugning the accuracy of the author's representation of the specimen in question.

The differences in colouration to which Day refers, and which are illustrated by Couch in his drawings of the "Carter" and "Sailfluke," appear to be due to the environment of the individual rather than to the existence of variety in pigmentation. Thus specimens obtained during the Survey from deep, or moderately deep, water, exhibited an uniform pale and slightly pinkish fawn-colour on the ocular side, varied, if at all, only with very faint greyish markings of indistinct outline. Such a colouration is reproduced, though somewhat unsuccessfully, in Couch's figure of the "Sailfluke." On the other hand, the dark ring-like markings shown in the figure of the "Carter" were only noticed in specimens from shallow water—most conspicuously in one taken at 4 to 5 fathoms in Loughrosmore Bay. Though no opportunity of testing the matter occurred, it may be safely predicted that such markings might be greatly modified, if not entirely obliterated, by exposing the specimen to different conditions of light, etc., as has been already done in the case of *Solea vulgaris* by Cunningham.‡ It is less probable that markings of similar intensity could be produced on uniformly coloured examples from deep water, at all events with the same rapidity, since, in the light of the more recent experiments of the same author,§ we are tempted to infer that the absence or insufficiency of light may affect the ocular as well as the blind side of the body, and that the dark chromatophores, to the expansion of which the ring-like markings are due, may fail to develop to the same extent as in shallow-water specimens.

* No ripe male was taken at less than 38 fathoms.

† It is frequent in *R. maximus*.

‡ "Treaties on the Common Sole," p. 110, "Mar. Biol. Assoc.," Plymouth, 1890.

§ "Zool. Anzeiger," 1891; or "Journ. Mar. Biol. Assoc.," vol. iii., No. 1, p. 111.

The sail-fluke is not included by Dr. Günther in the list of fishes collected by the "Flying Fox," but Mr. Green informs us that, during the cruise of that vessel, examples were obtained, in company with the allied *R. Boscii*, at a maximum depth of 315 fathoms. Vaillant records the capture of *Arnoglossus megastoma* at 303 fathoms off the coast of Morocco, while the same species is cited by Giglioli as having been found at considerable depths in the Mediterranean. Since, however, Day informs us that the author last quoted was the first to draw his attention to the identity of *R. Boscii* with the species now under consideration, it is uncertain to which of the two species the Mediterranean examples really belong.

On the Norwegian coast only a single example seems to have been recorded from deep water, viz. 100 to 200 fathoms off Bergen (Collett), though the species is stated to be common as far north as Trondhjem Fjord. In the North Sea the species is certainly far from common; a fact which may perhaps be cited as indicating that the physical conditions of the shallower grounds in our own seas are not so suitable as the comparatively deeper localities of the western coasts. In higher latitudes, however, it appears that the sail-fluke is frequent in very shallow water, since, as has been shown by one of us,* trawl fishermen who work the Iceland grounds report that the majority of sail-flukes are taken close inshore, especially at the "outfalls" of rivers or streams. A few words may be devoted to the remarkable accounts placed in currency by Richardson† and Couch‡ as to the manner in which this fish finds its way to the beach, viz. by using its tail as a sail. It would be ungracious to criticise the value of the evidence of the "scientific observers" cited, since the statement in question is the only criterion by which we have any means of forming an opinion. It is, however, permissible to suggest that there are mechanical difficulties which it is necessary to explain away. The story originated in North Ronaldshay, the northernmost of the Orkney Islands, and it had long been known to one of us, on the evidence of the proprietor and his family, that sail-flukes do actually come ashore there not infrequently, but always after storms, and not "when the weather happens to be calm," as averred by Couch's informant.

A visit to the island afforded opportunity for an inquiry among the crofters, which confirmed the connection between a storm and the arrival of the fish; and though the original tale of the method by which such arrival is achieved was still current, no one could be found who had actually witnessed it. The isolated position of the place and the want of occupation of any sort in the long winter cannot be supposed to be uncongenial to the survival, possibly also the inception, of a "yarn," and we cannot but think that the sail-fluke may deservedly be relieved from this imputation of habitual self-destruction.

* Holt, "Journ. M. B. A.," iii., 1884, p. 132. † Yarrel, "Brit. Fish.," 2nd Sup.

‡ "Brit. Fish.," iii., p. 163.

Rhombus norvegicus, Günther. The Norway Topnkot. (Littoral.)

Rhombus norvegicus, . . .	Günther, "Cat. Brit. Mus.," iv., p. 412.
,, ,, . . .	Günther, "Proc. Roy. Soc. Edinb.," xv., 1888, p. 217, pl. iv., fig. *C*.
,, ,, . . .	Holt, "Sci. Proc. Roy. Dub. Soc.," vii., 1891, pt. 3, p. 218.
,, ,, . . .	Cunningham, "Journ. Mar. Biol. Assoc.," vol. ii., No. 4, p. 325.
Pleuronectes or *Rhombus cardina*,	Cuvier, Tries, Ekström, Kröyer, Sunderall, and Nilsson.
Ekström's Topknot, ...	Couch, "Fish. Brit. Isles," p. 175.

Diagnosis of Species. (D. 80–83. A. 66–67. P. 8–10. L. lat. 50 ca.)*— Exclusive of the caudal peduncle, the shape is regularly fusiform, somewhat elongate; the greatest height of the body, situate opposite the extremity of the pectoral, contained about twice and a-half to twice and two-thirds in the total length, without the caudal fin. Caudal peduncle rather conspicuously elongate, its height equal to the length of the eye. The length of the head contained about three and a-half times in the total length, without the caudal fin. The eyes from two-sevenths to one-third of the length of the head, separated from each other by a high, narrow, scale-clad, and doubly-curved ridge; the lower eye but slightly in advance of the upper, which is close to the dorsal contour; the length of the snout slightly less than that of the eye; the lower jaw somewhat prominent; the upper jaw nearly one-third the length of the head, its posterior extremity extending beyond the front margin of the eye, but short of the level of a vertical from the pupil; teeth on the head of the vomer extremely small; lateral line with a sub-semicircular curve above the pectoral fin; pectoral of ocular side much larger than that of blind side; the fourth ray the longest, extending beyond the curved part of the lateral line; equal in length to the eye and snout; pelvic fins extending beyond the origin of the anal, but not continuous therewith; dorsal and anal fins of moderate height; dorsal commences in front of the eye; its first ray may be slightly elongate, and furnished on the blind side with a tapering fold of membrane; the last few rays of both dorsal and anal rather fleshy, forming small fan-like expansion on the blind side of the caudal peduncle; caudal fin rather large, almost truncate in posterior outline.

* These figures are based upon our own somewhat limited acquaintance with the species. Günther (Cat., *loc. cit.*) gives D. 78–80, A. 58–64.

Scales of moderate size, regularly arranged and ciliate on both sides of the body. On the ocular side they cover nearly the whole of the head, leaving only the lips, the extremity of the snout, and the eyes uncovered. Each fin-ray is accompanied by minute rough scales. On the blind side scales are absent from the jaws, the prominent parts of the pre-operculum, the outline of the gill cover, and from the fins. The greater number of the scales of the ocular side, with a somewhat angular margin, finely ciliate.

Scales may be present, however, which, when viewed microscopically, show the angle and small projections in the form of short, backwardly-directed, cone-like spines. Such scales may be most frequently found on the head, and more especially behind the eyes.

The ground-colour is a reddish chocolate, marbled with dark or black blotches. The most conspicuous blotches occur in series in the interspinous regions and along the course of the lateral line. In the latter situation there is a most conspicuous patch behind the curved part, and another a short distance in front of the caudal peduncle. Across the peduncle itself, near its origin, is a dark transverse band. The fin-rays are speckled and streaked with black. This is so more especially in the case of the dorsal and anal fins, the markings corresponding with those of the interspinous regions. Blind side unpigmented.

DESCRIPTION OF SPECIMENS.—The only example, taken during the Survey, was a male, exhibiting the following measurements:—

	CM.	INCHES.
Total length,	7·65	3 *ca.*
Total length without caudal fin,	6·40	2½ ,,
Length of head,	1·90	¾ ,,
Length of snout,	0·50	1/10 ,,
Length of eye,	0·60	11/64 ,,
Length of upper jaw,	0·70	¼ ,,
Greatest height of body,	2·70	1 1/16 ,,
Height of caudal peduncle,	0·60	11/64 ,,

In this specimen the fin-ray formula is *D* 83, *A* 67. The last three rays of dorsal and ventral form the posterior fan-like appendages on the blind side of the caudal peduncle.

The peculiar elongate scales, mentioned in the specific diagnosis, are present on the head. A few also occur on the body. These scales are shown in Van Wright's beautiful figure, in the original edition of Fries and Ekström's work. They are also visible in the inferior reproduction of the drawing in Smitt's edition. Günther's figure ("Proc. Roy. Soc., Edin.," *loc. cit.*) does not show them, nor are they mentioned in the text. This figure, however, corresponds so

closely, in all other respects, with the specimen under consideration, that we have not thought it necessary to produce another illustration.

Locality and Distribution. — Our single example was trawled on rough ground in Donegal Bay, 25 fathoms. The species was not previously known to Irish zoology, but several specimens had been recorded by Günther from the north of the British Islands, viz. from Shetland; Lamlash Bay, off Cloch Light-house, and Kilbrennan Sound, Firth of Clyde.

Couch also recorded a specimen from the Bristol Channel, and a number of examples were subsequently taken by Mr. Cunningham at Plymouth. The species may therefore be considered as fairly distributed on the British coasts.

The species is otherwise known from the coast of Norway, while recently Petersen* has recorded two specimens taken near Laesö, in 27 and 38 fathoms, on the Danish side of the Cattegat.

Rhombus Boscii, Risso. (Deep-sea.)

Rhombus Boscii, ... Günther, "Ann. Mag. Nat. Hist.," iv., 1889, p. 418.

" " . . . . . Bourne, "Journ. M. B. Assoc.," N.S., i., 1890, p. 306.

In view of the close resemblance which this species has been supposed to bear to the preceding, especial care was taken during the survey that the two should not be confused. Nearly all the sail-flukes taken came under the observation of one of us during the progress of the Survey in the fresh condition, and certainly all that occurred in deep water have been examined in either the fresh or preserved condition. The results of our examination has convinced us that *Rhombus Boscii* was never taken.

This is somewhat remarkable, since several were caught by the "Flying Fox" at 150 and 315 fathoms (Günther), while many were met with by the "Research" at 200, 217, and 70 fathoms (Sts. 1, 4, and 7, Bourne).

It appears, therefore, that the species is by no means rare in deep and moderately deep water off the S.W. coast; and its entire absence from the Survey collections would seem to indicate that it does not range further to the north than the grounds worked by the "Flying Fox" and "Research." The operations of these vessels, as appears from the accounts given by Messrs. Green and Bourne, took place well to the southward of the Irish coast, whereas the most southerly

* Petersen, "On the Biology of our Flat Fishes."—Report of the Danish Biological Station, 1894, p. 44.

haul made during the Survey occurred nearly due west of Mizen Head (see Chart, "Sci. Proc.," vii., pt. 4).

Günther (*loc. cit.*) has given a careful description of *R. Boscii*, calling attention at the same time to the work of earlier authors, of whom Vinciguerra and Kolambatovie are cited as having been the first to satisfactorily define the differences which separate it from *R. megastoma*. The author remarks that *R. Boscii* may be

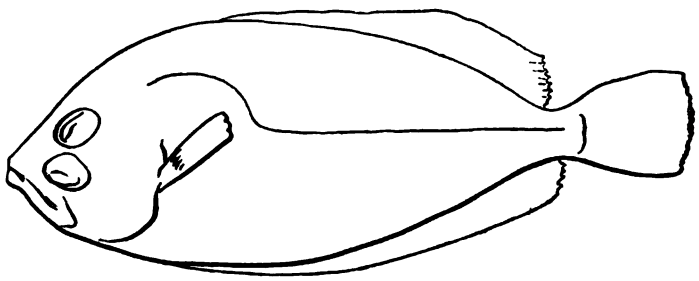


Fig. *G.*—*Rhombus Boscii.*

recognized at a glance by its enormous eyes, and, in support of this statement, cites the dimensions of a specimen of each species.

The only specimen of *R. Boscii* at our disposal is one from the Mediterranean, in the Science and Art Museum, at Dublin, a photo-outline of which is given in the accompanying figure. It measures 26·25 cm. in total length, and, on comparison with a Survey sail-fluke of exactly the same total length from deep water, the greater size of the eyes in *R. Boscii* is not apparent. The two fish, in fact, have

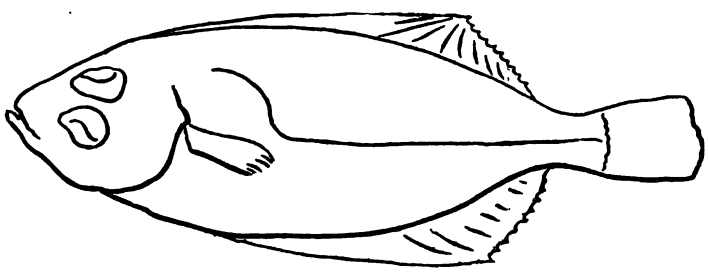


Fig. *H.*—*Rhombus megastoma.*

eyes of the same size; though, relatively to the size of the head, the eyes are somewhat the larger in *R. Boscii*, in which species, as Günther remarks, the length of the eye is one-third of the length of the head. In the specimen of *R. megastoma* the length of the head is about $3\frac{1}{4}$ times as great as that of the eye. In spite of this resemblance, the two fish can be recognised at a glance as distinct, without appeal to the difference in the fin-rays. The anterior profile is much more abrupt in *R. Boscii*, the upper and lower margins of the head forming a right angle at the anterior extremity. The angle so formed in *R. megastoma* is much more acute. The scales are conspicuously larger, and the bight of the lateral line

more rounded in *R. Boscii;* and, although in both specimens the greatest height of the body is about two-fifths of the total length, without the caudal, the shape is quite different. The abrupt rise of the dorsal profile in *R. Boscii* is continued backwards in a bold curve, while the ventral profile is correspondingly tumid.

The greatest height is reached at a point a little in rear of the base of the pectoral, and practically the same height is maintained as far back as a point, the distance of which from the snout is equal to the greatest height of the body. Behind this the body tapers rather rapidly towards the caudal peduncle. The sail-fluke is much more evenly fusiform in shape, the difference between the anterior and posterior tapering being less strongly marked, while the anterior profile, as already remarked, is very much more pointed. The spots on the dorsal and anal, present in *R. Boscii*, are of course wanting in the sail-fluke, though as Günther remarks that these are subject to fading, if the specimen becomes stale before being placed in spirits, it is evident that their absence cannot always be held to be of specific value.

It is quite possible that the eyes of deep-water specimens of *R. megastoma* may be larger than those of their littoral brethren, and we note that Day gives the length of the eye as one-fourth of that of the head, while in the specimen cited by Günther it measured $\frac{1}{5\frac{1}{2}}$ of the same dimensions. The specimen which we have represented for comparison with *R. Boscii* was taken from a depth exceeding 100 fathoms.

The dimensions of the Mediterranean *R. Boscii* are as follows:—

	cm.
Total length, ...	26·25
Total length without caudal, ...	25·55
Length of head, ...	6·66
Length of lower eye, ...	1·90
Length of upper jaw, ...	3·20
Greatest height of body, ...	9·40
Height of caudal peduncle, ...	1·70

The fin-ray formula is D. 82, A. 64. The spots on the dorsal fin are between the 65th and 68th, and the 75th and 77th rays; those of the anal between the 50th and 52nd, and the 58th and 60th. The last three rays of each fin are arranged in fan-like processes on the blind side of the caudal peduncle.

Genus **Arnoglossus**, Bleeker.

Arnoglossus laterna, Walbaum. The Scaldfish. (Littoral.)

Pleuronectes laterna, . . . Walbaum, Art. iii., p. 121.
Arnoglossus laterna, . . . Günther, "Cat. Fish. Brit. Mus.," iv., p. 417.

Arnoglossus laterna, . . .	GÜNTHER, "Proc. Zool. Soc.," 1890, p. 40.
,, ,, . . .	CUNNINGHAM, "Proc. Zool. Soc.," 1890, p. 540.
Platophrys laterna, . . .	SMITT, "Hist. Skand. Fisk.," ed. ii., p. 428.
Pleuronectes arnoglossus, . .	FLEMING, "Brit. An.," p. 197.
,, ,, . .	TURTON, "Brit. Fauna," p. 97.
,, ,, . .	BONAPARTE, "Faun. Ital. Pesc."
,, ,, . .	JENYNS, "Man.," p. 465.
,, ,, . .	CANESTRINI, "Arch. Zool.," i., p. 14.
,, ,, . .	YARRELL, "Brit. Fish.," ed. iii., i., p. 644.

DIAGNOSIS OF SPECIES.—D. 84–102. A. 64–81. Vert. 39–42. Reaches a length of 20 cm.

Scales of moderate size, very thin and deciduous, their free margins ciliate on the ocular, smooth on the blind side, rather angular in large males. Lateral line with an almost rectangular curve anteriorly, its scales not pierced by sensory tubes on the blind side. Teeth of equal size.

The length of the head about $4\frac{1}{2}$ times, and the greatest height of the body, situate about opposite the extremity of the pectoral, about $2\frac{1}{2}$ times in the total length, exclusive of the caudal. Anterior profile rather obtuse, especially in large males; jaws subequal anteriorly, the length of the maxilla of the ocular side about 3 times in large males and young examples of either sex, about $2\frac{1}{2}$ times in large females in the length of the head. The length of the eye about 4 times in large males, about 5 times in large females in the length of the head. Eyes separated by a very narrow, scaleless, bony ridge, the lower being in advance of the upper.

Dorsal and anal fin continued to the root of the caudal. In specimens exceeding about 13 cm. the second to the sixth dorsal rays become prolonged, the longest, in large males, being nearly equal to the length of the head. In females the longest ray does not exceed one-third of that measurement. Extremities of these rays free and filamentous.

The pelvic fin of the ocular side occupies the whole ventral edge from the isthmus to the anus. The pelvic rays become prolonged in large specimens, especially in males. Ocular side brown, with darker patches and mottlings. A black spot on the pelvic in males.

As is well known, the separation of *A. laterna* and *A. lophotes* was based, by the various authors who studied these two forms, chiefly upon certain differences in the length and character of the anterior dorsal and the pelvic rays, in the fin-ray formula, and in the proportions of the eyes and upper jaw. That most of these differences were merely sexual was first asserted by Mr. Cunningham (*loc. cit.*) in 1890, the author being led to this conclusion by the examination of a considerable number of examples of both forms taken on the S.W. coast of England.

To put the matter very briefly, he found that the elongation of the fin-rays, the large size of the eye, and the comparative shortness of the upper jaw (*i.e.* the most important characteristic of *A. lophotes*) were confined to male fish of over 13.2 cm. in total length, that in adult females the anterior rays were very slightly elongated, but that no such differences existed in examples of either sex less than 13.2 cm. long.

Taking these facts into consideration the author concluded that *A. laterna* was a sexually dimorphic form, of which examples hitherto classified as *A. lophotes* were simply full-grown males.

The greatest difficulty in the acceptance of this conclusion, and one which was present in the author's mind (*vide* p. 542), is found in the possibility of the existence of one species, in which the males and females are dimorphic, and of another smaller species which exhibits no dimorphism at all. Against this possibility the author seeks to guard by the assertion that, apart from the characters already discussed, all his specimens agreed with the descriptions given by previous writers of the species *A. laterna*, while the considerable and partial elongation of the fin-rays were confined, respectively, to males and females above a certain size. It may be permissible to suggest that the conclusion would have carried more universal conviction had it been supported by the enumeration of the proportions, &c., of a considerable series of both sexes at different sizes; this more especially since there is a discrepancy, in the fin-ray formulæ, which the author appears to have overlooked. On this account it appeared to us that any additional light, which a careful examination of the Survey scaldfish could throw on the matter, would be welcome; and, at the request of Dr. Günther, we have included in our investigation a small series of Norwegian examples.

A considerable number of scaldfish, all of the *A. laterna* type, were taken during the Survey, and about forty of these, ranging in size from 4·1 to 13 cm., were preserved. To Mr. A. R. C. Newburgh, of Bantry, we are indebted for four specimens of the *A. lophotes* type* trawled by him on the S.W. of Ireland. The list of British examples is completed by a single *A. laterna* from the coast of Yorkshire, while the Norwegian examples, conforming to the same type, are five in number.

As is usual in the case of scaldfish, a great part of our material was considerably injured, the scales or skin being partly or wholly wanting, and the fins more or less frayed and broken, but there remain a sufficient number of specimens of which the preservation, if far from perfect, is at all events, adequate for the purpose.

We append a list of the specimens selected for examination, with a Table of those proportions which are of chief importance in the present connection.

* Viz. three males with fully elongated rays, and a female with rays only slightly elongated.

Table of Dimensions and Proportions of Irish, North Sea, and Norwegian Specimens.

Category,	*A. lophotes.*	*A. laterna.*	*A. laterna.*	*A. laterna.*
Locality,	S. W. Ireland.	W. of Ireland.	Flamboro' Hd.	Norway.
Index letter,	*A*, *B*, *C*,‡ *D*	*E*, *F*, *G*, *H*, *J*, *K*, *L*, *M*,	*N*	*O*, *P*, *Q*, *R*, *S*
Total length in cm.,	18·5, 17·05, 16·85, 16·6	13·8, 12·0, 9·2*ca*, 8·3, 8·3, 8·1, 7·9, 8·1	12·4	12·2, 11·4, 10·2, 10·0, 10·4
Sex,	♂ ♂ ♀ ♂	♀ ♀ ♂ ♀ ♂ ♂ ♀ ♀	♂	♂ ♀ ♀ ♀ ♂
Length of head to total length, without caudal fin,	·22, ·22, ·24, ·23	·21, ·25, *, ·23, ·25, ·24, ·24, ·25	·25	·25, ·24, ·24, ·26, ·25
Length of lower eye to length of head,	·26, ·26, ·20, ·25	·23, ·23, ·23, ·24, ·27, ·23, ·24, ·26	·22†	·25, ·23, ·23, ·22, ·23
Length of maxilla to length of head,	·3̇3̇, ·31, ·36. ·31	·40, ·39, ·32, ·34, ·34, ·3̇3̇, ·34, ·33	·31	·31, ·3̇3̇, ·33, ·3̇3̇, ·32
Greatest height of body to total length, without caudal fin,	·39, ·40, ·41, ·33	·33, ·38, *, ·37, ·38, ·37, ·38, ·38	·43	·36, ·39, ·39, ·37, ·37

* The specimen is so much bent that these measurements cannot be accurately ascertained.

† Eyes badly preserved.

‡ This specimen, naturally, shows only the characters of *A. lophodus*, (Günther) in a modified degree. *Vide* text.

The results which may be deduced from this Table, and from the further observations which we are about to detail, must depend, in our opinion, very much on whether the large female *C*, which we have placed amongst the specimens answering to *A. lophotes*, be accepted as specifically identical with the males, *A*, *B*, and *D*, which are typical *A. lophotes*. For ourselves we regard the female as certainly belonging to the same species as the males, in the company of two of which it was taken by Mr. Newburgh. To such minor differences as do not appear from the Table we have made reference below; and the question of the identity of females, which, so far as they are described, appear to exactly resemble our single specimen, has been discussed by Mr. Cunningham at length.

We may first state that, if there is only one species, the elongation of the fin-rays, &c., has nothing whatever to do with sexual maturity. In fact all the specimens enumerated appear to be mature, with the doubtful exception of *J*, while *L*, the smallest of the series, only measures 7.9 cm. or about 3⅛ inches in total length. Mr. Cunningham, however, claimed only a relationship between size and the assumption of the secondary sexual characters, and does not mention the maturity of the sexual organs in connection with this phenomenon.

With regard to the fin-rays, our specimens *A*, *B*, and *D*, all show the typical *Lophotes* type. The longest ray in each individual is but little shorter than the length of the head, but the order of length differs as thus:—

A, ...	3, 4, 5, 2, 6.
B, ...	3, 2, and 4, 5, 6.
D, ...	5, 4, 3, 2, 6.

In the specimens cited by Mr. Cunningham the 4th ray was the longest, the order being given as 4, 3, 5, 2, 6. Hence it appears that the sixth is always the least elongated, but there is no constancy in the relative length of the rest. In all our examples there are traces of fin membrane between the basal portions of these rays, but the filamentous terminations appear to have been perfectly free. They are distinctly fleshy in appearance.

Specimen *C*, which is a female, has the longest ray a little more than a third of the length of the head, while the sixth ray is shorter than either the first or the seventh. The order of elongation of the rest is 3, 4, 2.

The pelvic rays in the three males have the elongation characteristic of *A. lophotes*, and appear to have been connected by membrane, in life, for the greater part of their length. The distal half of the membrane uniting the 4th and 5th rays of the ocular fin is black, the corresponding portion between the 5th and 6th rays being dark grey. Traces of a similar pigmentation can be detected in smaller males, but there is no evidence of its existence in any females, so that

it is probably a sexual character. The pelvic rays in the large female *C* are very slightly elongated.

Turning to those examples which are undoubtedly referable to *A. laterna*, *E*, a female of 13.8 cm., has the fourth, third, and fifth dorsal rays produced in the order named, the longest being nearly a fourth the length of the head. The smaller females of the Irish series show no traces of elongation of the rays. The largest of the males preserved is unfortunately only 9.2 cm. long. None of them have the dorsal rays perceptibly produced. The ends, however, are distinctly filamentous in specimen *J*. The smaller females, *E*, *H*, *L*, and *M* show no traces of differentiation.

The single North Sea example, *N*, a male of 12.4 cm., has the third dorsal ray slightly produced. Among the Norwegian fish, *O*, a male of 12.2 cm., has the third and second rays slightly elongated, the third ray being rather less than one-third the length of the head. None of the others have the rays at all produced.

Our series, therefore, incomplete though it is, does show such a difference in the degree of elongation of the fin-rays as might be expected if we were dealing with a single species characterized by the production of the rays in question (to an extent varying according to sex) when a certain size is obtained.

With regard to the general proportions we find nothing in the Table to indicate a distinction as between *A. lophotes* and *A. laterna*. The variation which is indicated in the proportion borne by the length of the head and the greatest height of the body, respectively, to the total length without the caudal fin seems to be chiefly individual, in so far as it is not merely developmental. The specimens agreeing with *A. laterna* have certainly a larger head, on the whole, than those possessing the characteristics of *A. lophotes*, but this is what might be expected if the former are merely younger stages of the latter. Individual variations in the height of the body is so well illustrated by comparison of *B* and *D*, both typical *A. lophotes*, that other differences in the whole series cannot be regarded as important. The single North Sea example has actually a higher body than any of the rest, but the want of other material from the same region precludes any profitable speculation as to the existence of *local* variations in this respect.

A peculiarity in shape, which does not appear from the proportions given in the Table, is the bluntness of the anterior profile in *A. lophotes*. The males, however, of this category exhibit this character more strongly than the female, *C*, while the anterior profile, though rather variable, becomes certainly more obtuse in the *A. laterna* series as the size increases.

The proportions of the eye and maxilla presented, perhaps, to some, one of the greatest difficulties in the acceptance of Mr. Cunningham's arguments as to the

identity of the two species, in the absence of an enumeration of these proportions in a series of examples extending over a considerable range of size. Our Table shows that, among specimens of the *A. laterna* type, the eye may be perceptibly larger in the male at a length of only 8.3 cm. (*cf.* *H* and *J*), while on the other hand no such sexual dimorphism may be apparent in specimens slightly larger (*G*), and the eye may even be largest in individual females amongst the smaller fish (*cf.* *M* and *R*). The proportions of the eyes in *N* are of no value, since the apparent smallness of these organs is obviously due to bad preservation. The reduction in the relative length of the maxilla in the male may evidently manifest itself in specimens of *A. laterna* of about 9 mm. (*cf.* *F*, *G*, and *H*), and it may (*H* and *O*) or it may not (*G*) be accompanied by a corresponding sexual dimorphism in the size of the eye. It will be noticed that, in the case of the eyes, there is a greater sexual difference in the large specimens (*A–D*), including the males conforming to *A. lophotes* than in any of the *A. laterna* type. This, as we think, tends to support rather than to refute the correctness of Mr. Cunningham's views, since a sexual dimorphism related to size would naturally become more pronounced with the growth of the individual. We also believe that the evidence which our Table affords of the occasional assumption of these features of sexual dimorphism in small examples of *A. laterna* greatly strengthens the case for the identity of the species.

Apart from the proportions of eyes and jaws, there is a discrepancy in the observed number of the dorsal and anal rays in *A. lophotes* and *A. laterna*. The value attached to even a considerable discrepancy in the case of forms in which the fin-rays are very numerous must depend largely on individual opinion, but it is certainly a matter which ought to be taken into account in an endeavour to establish the existence of a single species. Mr. Cunningham, however, only enumerates the formulæ of one male exhibiting the *A. lophotes* characters, and one large female, and of one female which, from its small size, was presumably typical of *A. laterna*. It so happens that the formula of the last-named example is considerably less than that of the other two, and is, in fact, illustrative of the discrepancy indicated by the observations of earlier writers.

In endeavouring to throw fresh light on the subject, we have counted the rays in a number of our own specimens, and have also collected the information available in existing literature.

The results are given in the following Table:—

A. lophotes.

	D.	A.		D.	A.
*British Museum types, . .	95	77	†Specimen from Plymouth, ♂	101	78
* ,, ,, ,, . .	96	76	† ,, ,, ,, ♀	96	75
* ,, ,, ,, . .	102	81	Survey Specimen, *A* . ♂	102	77
*Specimen from Lundy I., ♂	99	77	,, ,, *B* . ♂	95	74
* ,, ,, Palermo, ♂	98	75	,, ,, *D* . ♂	97	77
			,, ,, *C* . ♀	93	69

A. laterna.

	D.	A.		D.	A.
†Specimen from Plymouth, ♀	92	69	Survey specimen, {sex not ascertained,} .	87	70
Survey Specimen, *E* . ♀	90	71	,, ,, ,, .	90	67
,, ,, *F* . ♀	93	70	,, ,, ,, .	89	64
,, ,, *G* . ♂	94	70	,, ,, ,, .	90	72
,, ,, *H* . ♀	90 + ?	?	,, ,, ,, .	88	69
,, ,, *J* . ♂	89 + ?	?	Flamboro' Hd. Specimen, *N* ♂	85	?
,, ,, *K* . ♂	90	68	Norwegian Specimen, *O* ♂	84	67
,, ,, *L* . ♀	89	70	,, ,, *P* ♀	92	72
,, ,, *M* . ♀	88	66	,, ,, *Q* ♀	92	68
,, ,, . . ♀	88	68	,, ,, *R* ♀	90	68
			,, ,, *S* ♂	87	70

It will be seen from the Table that a formula of *D.* 94, *A.* 72, is only exceeded in the case of certain of the specimens which exhibit the general characters of *A. lophotes;* therefore, if we regard the two forms as distinct species, we get the following formulæ—

A. lophotes,‡ . . . . . *D.* 93–102. *A.* 69–81.
A. laterna, ... *D.* 84–94. *A.* 64–72.

* Teste Günther. "P. Z. S.," 1890, p. 40.

† Teste Cunningham (*loc. cit.*). The sex of the Lundy Island and Palermo specimens is given on the same authority.

‡ Including the large female, *C.*

Our own observations, therefore, so far from bridging over the discrepancy, tend rather to its further illustration. So few females of *A. lophotes* are available that we cannot say whether the comparative lowness of the formula in those examined possesses any significance. It is true that among the *A. laterna* examined, the maximum of dorsal rays is exhibited by a male (Specimen *G*), but the same is also true of the minimum (Specimen *O*), and we are quite unable to state, from the material at our disposal, that there is any constant sexual difference in the number of rays in the smaller forms.

The formula, compiled after the assumption of specific identity in all the examples cited, is *D.* 84–102, *A.* 64–81. This involves a variation, perhaps, more considerable than has been demonstrated in the case of any other single species having approximately the same number of rays, but we do not think that it is by any means so excessive as to preclude the possibility of the existence of only one species. It so happens that less than 87 dorsal rays are only met with in the case of one of the Norwegian examples. Variation of the fin-ray formula, as of other characters, in relation to locality, would be in no way surprising; but Collett, who has studied the matter in the case of *Hippoglossoides platessoides*,* found that it was the most northern examples that possessed the most numerous rays, and not the most southern, as in the present instance.

It should not be forgotten that scaldfish almost invariably arrive on deck in an extremely frayed condition. Some of our specimens are, indeed, so much injured that, as will be noticed in the Table, we have not attempted an exact definition of their formulæ; and if we admit that in the case of some other small specimens we may have failed to detect the defection of some few rays that were lost in capture, we do not believe that this will be held, by those who have had experience of the species, to be tantamount to a confession of general incompetence of observation. If such has been the case, it is quite possible that the natural condition involves no material discrepancy between the forms exhibiting, respectively, the character of *A. lophotes* and *A. laterna;* but it must be noted that Specimen *Q*, the most perfect of the whole series, has certainly a formula of only *D.* 92, *A.* 68.

The scales in the specimens forming our series are so imperfect that they can only be counted, with any approach to accuracy, in four. It is noticeable, however, that the scales of the male *A. lophotes* have the posterior margins rather more angular than in the female and in the smaller specimens (*A. laterna*). There is a difficulty in counting the number of rows which cross the lateral line in any example, as the rows crossing the anterior curved portion of this structure are so irregular that the defection of a few scales causes great confusion. It seems, therefore, preferable to enumerate the rows which cross a straight line formed by

* "Norwegian North Atlantic Expedition," p. 144.

continuing the straight part of the lateral line forwards to the head. The result is then as follows:—

A, . . . 59 or 60, of which 47 rows cross the straight part of the lateral line.
B, . . . 57, of which 46 rows cross the straight part of the lateral line.
C, . . . 51, ,, 40 ,, ,, ,, ,, ,, ,,
Q, . . . 50, ,, 39 ,, ,, ,, ,, ,, ,,

C and *Q* are both females, and if the specific identity of the former with the males *A*, *B*, and *E* be allowed, there is obviously nothing in the number of the scales to separate *A. lophotes* and *A. laterna*.

As to the colours, we have already noted the existence of a black patch on the ocular pelvic, which appears, throughout the series, to be confined to males. The specimens *A* and *B* (*A. lophotes* ♂) are sufficiently perfect to show the colours of the ocular side, which, in spirit specimens, consist of a greyish brown (darkest, on account of the peritoneal pigment over the abdominal region) mottled all over with dark grey and black markings, of which the larger show a tendency to arrange themselves along the interneural regions and the lateral line. The lips and jaws are dark grey, with dark markings, and the rays of the dorsal, anal, caudal, and pelvic fins are banded with black, except on the extremities of the elongated rays. Dr. Günther ("P. Z. S.," 1890, p. 40) supposed that the markings shown in Day's figure of the Lundy Island specimen of *A. lophotes* ("P. Z. S.," 1882, pl. liii.) were reproduced from a veritable example of *A. Grohmanni*, the species with which Day identified it. Comparison with a specimen of *A. Grohmanni* in our possession shows that this might be the case without much imparing the value of the figure, as *A. Grohmanni* differs from *A. lophotes* chiefly in having a somewhat darker head. The specimen *C* has the lips and jaws a good deal lighter than in the *lophotes* males, and the fin-rays are only feebly banded with pigment.

The Norwegian female *O* has the ocular side a uniform brownish grey (darkest over the abdominal and ovarian region) very faintly marbled with a darker shade. The jaws are rather pale, and the fin-rays are only faintly pigmented. This last condition seems to hold good for all the *A. laterna* series, which are otherwise too much injured for satisfactory observation of the pigment.

After we had completed the examination of the Survey and other specimens mentioned above, Mr. Cunningham most generously placed at our disposal a large series of examples from Plymouth. These comprised 12 typical *A. lophotes* males, and six large females, showing the slight elongation of the anterior rays, similar to the female *D* of the Irish series. In addition there are seven smaller examples, five males and two females. This augmentation of our material was most valuable, since it eliminates from our work a great part of the risk which must always

accompany conclusions based on the examination of a limited number of specimens. The large females are especially valuable, since the specimen *C* was previously the solitary representative of this stage of the sex.

The Plymouth examples arrived too late to be incorporated with the rest in one series without great inconvenience, and we believe that to deal with them, as it were, in an appendix to our previous remarks will be as useful as to rewrite the whole.

The specimens agree with those described by Mr. Cunningham himself in having lost all the scales, except some of those of the lateral line, and, in most cases, a great part of the skin also, and are thus in a worse state of preservation than the few large Irish specimens. They are, however, none the less valuable for comparison.

The appended Table gives the more important particulars of the dimensions of the majority of these specimens, with their fin-ray formulæ. The individuals are denoted by Roman numbers:—

Table of Dimensions, Proportions, and Fin-ray Formulæ of Specimens communicated by MR. J. T. CUNNINGHAM.

—	LARGE MALES.							LARGE FEMALES.						SMALL MALES.			SMALL FEMALES.	
Index number, ...	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.
Total length in cm., ...	19·4	19·3	18·8	18·35	16·3	15·4	15·3	18·7	18·7	16·4	16·3	15·5	15·3	9·3	9·0	8·4	10·8	10·15
Length of head to total length, without caudal fin, ...	·22	·22	·23	·23	·23	·24	·24	·23	·22	·22	·21	·22	·23	·24	·25	·24	·24	·24
Length of lower eye to length of head, ...	·27	·27	·27	·27	·28?	·25	·29	·27	·22	·27	·26	·26	·26	·26	·23	·23	·23	·24
Length of maxilla to length of head, .	·33	·32	·30	·27	·31	·29	·29	·32	·33̇	·32	·33̇	·30	·33̇	·31	·31	·35	·39	·36
Greatest height of body to total length, without caudal fin, . . .	·40	·39	·41	·43	·39	·39	·37	·39	·36	·40	·38	·37	·42	·39	·38	·36	·39	·38
Number of dorsal rays, . . .	99	102	99	97	97	99	94	98	99	96	98	97	?	92	92	89	91	91
Number of anal rays, . . .	75	75	78	75	79	77	76	80	78	76	78	78	76	71	70	68	68	70

A glance at the column showing the proportion borne by the length of the eye to the head shows that the sexual dimorphism in this respect is much less striking than would be inferred from the four large Irish examples, in which the female *C* has an eye conspicuously less than any of the three *A. lophotes* males. In the Plymouth series, though the average size of the eye is certainly greatest in the males, in two (viii. and x.) out of the six large females it is of the same size as in four of the males (i.–iv.), and is actually greater than in one male (vi.). It must therefore be said that sexual dimorphism of this feature is not invariably apparent even in full-grown examples. The condition of the younger examples only further illustrates the variation of the size of the eye, or of its differentiation in relation to sex, which we have already noticed in similar stages from other localities. It is not certain that any of the small Plymouth examples are sexually mature, but specimen xviii. is at least approaching that condition. With regard to the length of the maxilla the Plymouth series again greatly reduces the sexual difference apparent from the examination of the few large Irish examples, though the average larger size of this structure in the female is maintained. The condition of the younger examples so far coincides with that of the small Irish and Norwegian specimens as to indicate that the jaw is usually largest in the female at a comparatively early age.

In dealing with the larger Irish examples (*A–D*) it was noted that the profile was blunter in the males than in the female. The same conclusion is borne out by examination of the twelve males and six females from Plymouth, but in a modified degree. The profile is more abrupt and blunter in some males than in any females; but the sex of several examples cannot be distinguished by this character. The small examples, male and female, are indistinguishable from each other in shape, and are more fusiform in appearance than the largest *A. lophotes* males, and some of the largest females. They agree, however, with the smaller of the large females, and with some of the smaller *A. lophotes* males. Since the same is the case with the smaller Irish examples, it may be taken that the profile becomes blunter with age, especially in the male.

The black spot on the ocular pelvic, noted in the Irish males, is present, or at least indicated, in the Plymouth males, but cannot be detected in the females.

The variation in the elongation of the anterior dorsal rays is shown by the following figures:—

Index number.	Length of head.	Length of longest ray.	Order of elongation.
♂ i.	3·60 cm.	3·30 cm.	3. 4. 2. 5. 6.
,, ii.	3·70 ,,	3·75 ,,	3. 4. 5. {6 2}. 7.
,, iii.	3·60 ,,	2·90 ,,	4. 3. 5. 2. 6. 7.
,, iv.	3·60 ,,	3·00 ,,	3. 4. 5. 2. 6.
,, vi.	3·10 ,,	2·70 ,,	3. 4. 5. 2. 6.
,, vii.	3·08 ,,	2·40 ,,	4. 5. 2. 3. 6.
♀ viii.	3·70 ,,	1·40 ,,	4. 3. 2.
,, ix.	3·60 ,,	1·70 ,,	3. 2. 4.
,, x.	3·10 ,,	1 15 ,,	3. 2. 4.
,, xi.	3·00 ,,	1·20 ,,	{2. 3. 4.
,, xii.	3·00 ,,	1·30 ,,	3. 2. 4.
,, xiii.	3·00 ,,	1·30 ,,	3. 2. 4.

In the smaller examples of either sex the anterior rays are not elongated. It will be noted from the above enumeration that there is no constancy in the order of elongation in the males; also, that the longest ray may be actually longer than the head (specimen ii.), and that the seventh ray may be elongated (specimens ii. and iii.), conditions which appear to have escaped the attention of other observers. The elongation of the anterior rays in the large females seems to be confined to the 2nd, 3rd, and 4th rays, and, in the small series before us, shows a certain regularity in order. Taking all our material into consideration it appears that, in either sex, the 3rd ray is usually the most elongated, and the 6th (or 7th) the least.

The fin-ray formulæ of the large Plymouth females serve to show that the sexual discrepancy in the large Irish examples is, so to speak, a matter of chance, and not due to sexual dimorphism; but, as in the case of the Irish series, we again find that the formulæ of the small specimens is lower than that of the large ones. The enumeration of the rays of the large males and females certainly tends to associate them as one species; but the difficulty presented by the discrepancy between these (which we may term *A. lophotes*, ♂ and ♀) and the smaller undifferentiated examples of either sex is by no means lessened by the Plymouth material.

The state of the specimens was such that we were only able to count the scales of the straight part of the lateral line in five examples, all small. The number varied from 38 to 40, being 38 in two, 39 in one, 39 or 40 in one, and 40 in one. In two specimens the total number of rows of scales between the head and the caudal fin could be ascertained. In one it is 48, in the other 50. Thus the small Plymouth examples agree with the Norwegian specimen *Q*, and with the large Irish female *C*, but have a considerably less number of rows than the Irish *A. lophotes* males *A* and *B*.

It appeared probable that information of value might be gained by counting the vertebræ, which we accordingly exposed in several specimens, with the following results:—

A. lophotes, male, . .	Plymouth, .	D. 99	A. 77	Vert. 41.
,, ,, ,, . .	,, . .	,, 94	,, 76	,, 42.
,, ,, ,, . .	,, . .	?	?	,, 41.
,, ,, large female,	,, . .	,, 97	,, 78	,, 42.
,, ,, ,, ,,	,, . .	,, 98	,, 78	,, 41.
,, ,, small male,	,, . .	,, 89	,, 68	,, 39.
,, ,, ,, ,,	,, . .	?	?	,, 39.
,, ,, small female,	,, . .	,, 91	,, 68	,, 39.
,, ,, small male,	Ireland, . .	,, 94	,, 70	,, 39.
,, ,, small female,	,, . .	,, 88	,, 66	,, 39.
,, ,, ,, ,,	,, . .	,, 90	,, 71	,, 39.
,, ,, ,, ,,	,, . .	,, 93	,, 70	,, 39.

It is apparent that, if we have counted correctly, all the small examples have 39 vertebræ, and all the larger ones, whether male or female, either 41 or 42 vertebræ. Since the number of vertebræ is known to roughly correspond in Pleuronectids to the number of the fin-rays, it seems probable that the small examples have actually a less number of fin-rays than the large ones, so that the difficulty is not to be explained away as due to an error in counting the rays. We are not aware of any observations showing that the number of either rays or vertebræ increase with age, and do not regard this as probable. A variation of two or three in the number of the vertebræ in a species is by no means remarkable, but it is remarkable that we should have found such a constant variation in relation to the size of the individual. The variation is confined to the caudal region, the number of abdominal vertebræ being nine in both large and small examples.

Taking all our information into consideration it appears to us that the evidence of the identity of *A. laterna* and *A. lophotes* is sufficient to outweigh the difficulty

presented by the fin-rays and vertebræ, the more especially since the large Irish female *C* is a connecting link between the fin-ray formulæ of the larger and smaller forms, and probably also in regard to their vertebral formulæ.

We have accordingly included *A. lophotes* in our list of synonyms. A further argument to the same effect is perhaps furnished by the absence of any small examples that can be said to belong to *A. lophotes* rather than to *A. laterna.*

Although in this Paper we have given details of no specimens of a less total length than 7·9 cm., we have examined practically all lesser sizes of adult form, and can detect no difference to which specific value could possibly be assigned. The smallest specimens have been described and figured by one of us in a previous number of these "Transactions."* On the other hand it will be argued that no fish exhibiting the characters of *A. lophotes* have been recognised from Scandinavian waters, where *A. laterna* appears to be fairly plentiful. It must be remembered, however, that, previous to 1822, *A. lophotes* was only known to science from three dried skins of unknown locality; the number was then increased by the capture of the Lundy Island specimen, and when, in 1890, Cunningham first recorded the abundance of this form on the S.W. coast of England, only one other specimen (from Palermo) had been added, while this Paper furnishes the first record of the existence of the form in Irish waters. Hence it is no slur on Scandinavian naturalists to suggest that *A. lophotes* may yet be discovered within the Scandinavian area.

But there is another consideration which may not be without weight. It is matter of common knowledge that the growth of fishes is greatly affected by conditions of food and environment. This being so, may it not be that a species, which, in certain localities, attains a large size, accompanied by developmental and sexual metamorphosis of several structural characters may, in a district less favourable, remain permanently stunted, and fail to exhibit the final metamorphosis ?

In the case of the Salmonidæ we know that this may happen; and the analogy of this family leads us to a speculation as to the probable factor of the evolution of the secondary sexual and late developmental characters of the scald-fish. We have seen that they are in no way related to sexual maturity, but simply to size.

The experiments of Sir J. Gibson Maitland (to whom we are indebted for much courteous information in answer to our inquiries), in the breeding of Lochleven trout, have established the fact that the offspring of young parents retain, throughout life, a great similarity to the common brown trout (*S. fario*), whereas the offspring

* "Trans. Roy. Dub. Soc.," vol. v. (series II.), p. 75.

of old parents pass through the various "smolt" and "grilse" stages, and finally resemble their parents in every respect.

If, as we are entitled to assume, the attainment of a large size is for the advantage of the species, it is obvious that that advantage would accrue from the development of any character which would induce the largest fish to mate with each other; such a character is presumably furnished in the case of large *S. levenensis* by the peculiar pigmentation of the adult, and it is possible that the more pronounced characters (in this case sexually dimorphic) of the scaldfish may be interpreted in the same way. It so happens, however, that Sir J. Maitland finds that the size of the male parent is of no apparent importance in trout, and that the size of the offspring depends on the size of the egg, which, in turn, is in proportion to the size of the parent female.* Such being the case, the object of the accessory sexual characters of the male scaldfish is not apparent, if we were not aware that there is a mechanical difficulty in the fertilization of the ova of young females by the spermatozoa of old males, which Sir J. Maitland informs us is the case. From this it is evident that an old male can only reproduce its species by union with a mate of corresponding size, and possibly the elongated rays of the old male scaldfish may assist in securing this object. In any case it seems quite reasonable to suppose that, as in the case of the Lochleven trout, the offspring of young or small scaldfish may never attain the characters of the full-grown fish, so that within the limits of one species there may be two well-marked forms—one attaining a large size, and becoming sexually dimorphic, while the other remains permanently stunted and practically indistinguishable as to sex by external characters.

It may be further conjectured that the elongation of the rays in old males is not merely, as it were, ornamental, but of actual service in the discharge of the sexual function. Little is, or is likely to be, known of the breeding habits of sea fish, but it is quite possible that there may be some sort of conjugation in which the elongated rays may play an important part as organs of prehension.

A Mediterranean scaldfish, *A. conspersus*, Canestr., is considered by Professor Smitt to be identical with *A. laterna*. On this matter we have no opportunity of offering an independent opinion. In discussing the species, Smitt makes no mention of Mr. Cunningham's Paper, either in the list of references or in the text. This might be taken as a rather forcible method of indicating dissent from the views therein expressed, were it not that the author, though he has chosen to publish in English, shows no signs of having attempted to make himself acquainted with the observations of recent British writers.

* A fact which probably holds good for sea-fishes, and accounts for the discrepancies in statements by different writers as to the dimensions of the ovum of a species.

Arnoglossus Grohmanni, Günther. (Littoral.)

Pleuronectes Grohmanni,	.	BONAPARTE, "Fauna Ital. Pesc."
,, ,,	.	CANESTRINI," "Arch. Zool.," i., p. 12.
Arnoglossus ,,	.	GÜNTHER, "Cat. Brit. Mus.," iv., p. 417.
,, ,,	.	CUNNINGHAM, "Proc. Zool. Soc., London," June, 1890.
,, ,,	.	HOLT, "Proc. Roy. Dub. Soc.," vii., p. 228.

DIAGNOSIS OF SPECIES (D. 86–90; A. 60–67; P. 9–10; V. 6; C. 17; Lat. L. 56).—The height of the body two-fifths of total length (without caudal). Scales deciduous. Lower jaw slightly prominent; the length of the maxillary is rather less than one-third of that of the head. Eyes very close together, the lower in advance of the upper. The second dorsal ray separate, elongate. A dingy brown, clouded with darker patches, arranged in three irregular rows.

Previous to the Survey only two specimens of this fish had been taken in British waters: one obtained by Mr. Spottswood Green from the Kenmare river, in 10 fathoms; the other by Mr. Garstang, described by Mr. Cunningham (*loc. cit.*), in Cawsand Bay, Plymouth Sound, in 4 or 5 fathoms. Four examples are now added as a result of the Survey, one an adult male, and three young specimens, taken at Killybegs. It therefore seems probable that this Mediterranean fish is more common on our coast than had been supposed. In the above diagnosis we have followed Günther as to the relative height and length of the species, because our adult example exactly corresponds with this statement. In the specimen described by Cunningham, the greatest height is stated as "being contained $2\frac{1}{2}$ times in the total length, including the caudal fin." Unfortunately the length of the caudal fin is not stated. Since, however, the length of our adult specimen with the caudal fin added, is, as nearly as possible, twice the extreme height (including dorsal and anal fins), the Plymouth specimen may be of less height. This appears the more likely, since, in another part of Mr. Cunningham's Paper, the extreme length is given as 15·3 cm., the extreme breadth as 5·7 cm.

The fin-ray formula has been constructed from the observations of Canestrini, Cunningham, and from our own specimen.

Canestrini D. 90; A. 60–67.
Cunningham D. 87; A. 66; P. 10; V. 6; C. 17.
Survey specimen D. 87; A. 63; P. 9; V. 6; C. 17.

The great variation in the dorsal and anal fins stated in our diagnosis springs, therefore, from Canestrini's data. We have disregarded the formula of Bonaparte, as showing an excess of variation, or, at all events, a variation which appears to be improbable from the study of British specimens. His formula is D. 80; A. 52; Lat. line, *ca.* 45.

In view of the deciduous character of the scales, we are fortunate in having an almost complete specimen. We have, therefore, no hesitation in giving the number of scales on the lateral line as 56. The scales of the upper side have setose margins, those of the under side are smooth. In our specimen the second and third dorsal fin-rays are elongate, the second being pronounced in this respect (1·5 cm.) in conformity with the character of the species. The first and second are alone free. In the Plymouth specimen the second, third, and fourth rays are elongate, the second having a broad plicated membrane stretching to an equal extent on both anterior and posterior sides of the ray, the whole tapering and curving towards the tip. In our specimen the membrane is not conspicuous on the anterior side, nor can it be described as at all plicated. It gives the appearance rather of a primary feather from a bird's wing. The conditions exhibited by the two specimens show that either this secondary sexual character is capable of considerable variation, or, as is more likely, our adult example (which is smaller than Cunningham's) is in a stage intermediate between that of the young examples, in which the rays, though separate, show no membraneous margins, and that shown in Cunningham's specimen, which is figured.

The proportions of our adult specimen may be more clearly understood from the following measurements:—

Length, including caudal fin,	12·1 cm., or 4¾ inches.	
Length without caudal fin,	10·0 ,,	or 3 15/16 ,,
Extreme height,	6·3 ,,	or 2½ ,,
Height without fins,	4·5 ,,	or 1¾ ,,
Length of head,	2·7 ,,	
Length of eye,	0·7 ,,	
Length of second dorsal fin-ray,	1·5 ,,	

Genus **Pleuronectes**, Günther.

Pleuronectes cynoglossus. The Craig-fluke or Pole-dab.* (Deep-sea.)

Glyptocephalus cynoglossus,	.	Goode, "Proc. U. S. Nat. Mus.," iii., 1880, p. 475.
,,	,,	. Goode, "Bull. Mus. Comp. Zool., x., 1883, p. 195.
,,	,,	. Collett, "Norw. N. Atlant. Exp. Fish.," p. 150.
,,	,,	. Collett, "Forh. Vid. Selsk. Christ.," 1880, p. 82.
,,	,,	. Strom, "Norsk. Vid. Selsk., Skrw.," 1884, p. 39.
Pleuronectes	,,	. Holt, "Sci. Proc. Roy. Dub. Soc.," vii., p. 121.
,,	,,	. Holt, "Trans. Roy. Dub. Soc.," N.S., v., p. 84.

* This fish is called "Witch," or "Witch Sole," on the East coast of Great Britain. It is the "White Sole" of the Dublin market, though *R. megastoma* is also frequently dignified with that title for commercial purposes.

This is the only flatfish known to descend beyond a depth of 500 fathoms. It has been recorded by Goode, from off the Atlantic coast of the United States, at depths of 120, 263, 395, 603, and 732 fathoms; by Collett, off Lofoten and Finmark, at 125 to 150 fathoms; by Strom, in Trondhjem Fjord, at 200 fathoms; and by Bourne, off the S.W. of Ireland, at 200 fathoms. During the Survey three specimens, from 5 to 6 inches in length, were trawled at 144 fathoms, and four others, larger, but of no great dimensions, were taken at 220 fathoms. The species was also met with in littoral waters (*vide* "Sci. Proc.," vii., pp. 343, 409, 447).

In the large size of the eyes, and comparative slenderness of the structural parts, *P. cynoglossus* bears a certain resemblance to *R. megastoma*, and it may be said that the two species have very much the same vertical distribution on our own coasts, the former occurring most abundantly on the east, and the latter on the west coast. In northern latitudes craig-flukes are found in quite shallow water, as at Iceland,* as well as at the considerable depths noted above; but the species does not appear to have been met with by the French "Travailleur" and "Talisman" expeditions at any depth in the South Atlantic; and the Bay of Biscay, where it is known to occur, at moderate depths, in some numbers, is perhaps the southern limit of its range.

Collett (*op. cit.* p. 151) was the first to demonstrate that *P. elongatus*, Yarrell., is merely a young stage of *P. cynoglossus*. In dealing with the development of the species in a former number of these "Transactions" (*t. c.* p. 88, pl. xv., fig. 124) an example, illustrative of the *P. elongatus* stage, has been given by one of us.

Genus **Solea**, Klein.

Solea vulgaris, Quensel. The Common Sole. (Deep-sea.)

Solea vulgaris, ... VAILLANT, "Exp. Sci. Trav. Talism., Poiss.," p. 189.

The sole must be admitted into the category of deep-sea forms on the strength of the capture of a specimen by the French scientific expedition, at 127 fathoms, on the Banc d'Arguin. The species is well known to congregate in certain of the deeper parts of the North Sea in hard winters. The Great Silver Pit, the most noted of these grounds, has a maximum depth of about 60 fathoms, which is, we believe, with the exception referred to above, the greatest depth at which soles are known to have been taken.

* *Vide* "Journ. M. B. Assoc.," iii. 1894, pp. 130, 132.

Solea lascaris, Risso. The Lemon-sole or Sand-sole. (Littoral.)

Three examples were taken in Blacksod Bay, viz. two on the trawling-ground, at 5½ to 9 fathoms, and one at the margin in the small inlet known as Dugort Bay.

Solea Greenii, Günther. (Deep-sea.)

S. Greenii, ... Günther, "Ann. Mag. Nat. Hist.," iv., 1889, p. 419.
,, ... Bourne, "Journ. M. B. Assoc.," N.S., i., 1890, p. 312.
,, ... Cunningham, "The Common Sole, Plymouth," Mar. Biol. Assoc., 1890.

The species is known from only two examples. Of these, the first was taken by Mr. Green, in the "Flying Fox," at 150 fathoms, and the second by Mr. Bourne, at 217 fathoms, in both cases off the S.W. coast of Ireland. The species has been described by Dr. Günther and by Mr. J. T. Cunningham. It appears to be of no great size, since a specimen of 18·8 cm. was found to be a sexually mature female. It is regarded by Günther as allied to *S. vulgaris* and *S. variegata*, between which two forms it is in some particulars intermediate. By comparison of descriptions it appears to us to closely resemble *S. profundicola* (Vaillant), a deep-water sole from the South Atlantic.*

Solea variegata, Fleming. The Thickback. (Deep-sea.)

S. variegata, ... Vaillant, "Exp. Sci. Trav. Talism. Poiss.," p. 190.
,, ... Günther, "Ann. Mag. Nat. Hist.," iv., 1889, p. 419.

An example, 4 inches long, was trawled at 40 fathoms in Dingle Bay, and another, about one inch long, was found in the stomach of a piper gurnard taken at 62 to 52 fathoms off the Skelligs. The thickback is known to habitually frequent rather deep water. There are two records of its occurrence beyond the 100 fathom-line, viz. at 162 fathoms in the Bay of Biscay, (Vaillant) and at 150 fathoms off the S.W. of Ireland (Günther).

* Vaillant, "Exp. Sci. Trav. Talism., Poiss.," p. 190.

Fam.—SALMONIDÆ.

Genus **Argentina**, Artedi.

Argentina sphyræna, Linnæus. (Deep-sea.)

A. sphyræna, ... COLLETT, "Norg. Fisk.," p. 171.
" " . . . . . HOLT, "Sci. Proc. Roy. Dub. Soc.," vii., pp. 122, 220.

When dealing with the genus in his "Challenger" Memoir,* Dr. Günther considered that the European species of Argentina lived at a considerable depth, but probably not at the bottom, since, at the time of writing, they had not been captured by the dredge, or trawl, during any of the deep-sea expeditions. During the Survey, however, a considerable number of *A. sphyræna* were taken in the trawl. This is not necessarily a proof that the specimens were caught at the bottom, since they may have entered the net during either its ascent or descent, but it is significant that the greatest number were taken in company with essentially bottom forms, such as flatfish and gobies, and with *Gadus argenteus*, a species probably referable to the same category.†

Several specimens were also found in the stomach of a skate (*R. oxyrhynchus*), a fish which presumably does not range very far from the bottom in pursuit of food. The specimens captured were distributed as follows:—A considerable number, about $1\frac{1}{2}$ inches long, at 62 to 52 and 80 fathoms, off the Skelligs; several, a little larger, in the stomach of the skate, trawled at 500 to 375 fathoms, off Achill Head; three, $3\frac{1}{4}$ inches long, at 40 fathoms, and one, $5\frac{1}{2}$ inches long, at 53 fathoms, in Dingle Bay.

The species thus appears to be not uncommon on the west coast, as seems also to be the case on the west of Scotland, whence Günther has recorded a considerable number from 32 to 27 fathoms. Collett found specimens in the stomach of a ling caught at 200 fathoms, on the coast of Norway, apparently the only exact record, previous to the present, of its occurrence below the 100 fathom line.

The appearance of the smaller specimens is shown in fig. *J*, which represents a spirit specimen, 37 mm. in total length, magnified three diameters. The head and eyes are, of course, much larger, relatively, than in the adult. There are no scales, but the skin is silvery, especially on the sides and gill-cover: the eye is

* "Chall. Rep. Zool.," xxii., p. 217.

† For full list of other species see results of Sts. 114 and 115 ("Sci. Proc.," vii., pp. 258, 259). *A. sphyræna* has been accidently omitted.

silvery, with black markings. Black pigment is present, chiefly in the form of isolated chromatophores, or small groups of chromatophores, but there is a dark patch on the top of the head, as in the adult, and another at the base of the pelvic fins. Eight small groups of chromatophores occur along the course of the lateral line, and the base of each ray of the first dorsal and anal fin is decorated with a black spot. The dorsum is finely powdered with small dark dots, while larger ones occur on the gill-cover and at the caudal extremity. There is a groove along the dorsum, from which arise the basal ridges of the nine rays of the first dorsal fin. The sides are slightly flattened, and the ventral abdominal region is somewhat biconcave. Beyond this there is no trace of the polygonal shape (in section) of the adult (*cf.* Day, "Fish. Gt. Brit.," ii., pl. cxxv., fig. 2).

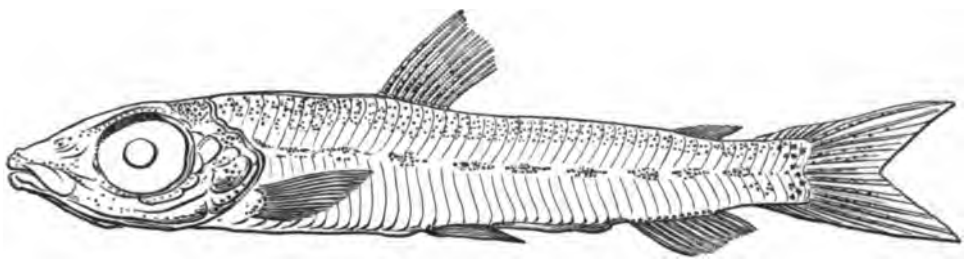


Fig. *J.*—*A. sphyræna*, Juv. Reduced × ½.

Fam.—MURÆNIDÆ.

Group **Anguillina**, Günther.

Genus **Conger**.

Conger vulgaris, Cuvier. The Conger. (Deep-sea.)

C. vulgaris, ... Holt, "Sci. Proc. Roy. Dub. Soc.," vii., p. 220.

A large specimen was trawled at 154 fathoms, 28 miles off Achill Head, on 20th April, 1891.

Off the Inner Hebrides, Scotland, a few boats from the east coast carry on a conger fishery in deep depressions of 70 to fully 100 fathoms.

Group **Mursenesocina**, Günther.

A small eel, trawled at 144 fathoms, off Achill Head, forms the type of a new genus and species, of which one of us has already given a description, now reprinted with a few verbal alterations.

Genus **Nettophichthys**, . . HOLT, "Sci. Proc. Roy. Dub. Soc." vii., p. 122.

Scaleless. Snout much produced; depressed. Jaws and vomer with rows of teeth, recurved in anterior region, largest in central region of vomer. Gill openings fairly wide, open. Vertical fins confluent, rather feebly developed. Pectoral fins absent. Anterior nostril on upper surface of head near end of snout. Posterior nostril on side of head in front of eye. Air-bladder present. Pyloric appendages absent.

As will be seen from the above description, this genus is intermediate between *Nettastoma*, Raf., and *Saurenchelys*, Peters, agreeing with the latter in the condition of the nostrils, and with the former in the possession of an air-bladder. In the comparatively feeble character of the vertical fins it recedes equally from both.

TYPE SPECIES.

Nettophichthys retropinnatus, Holt, *loc. cit.* (Deep-sea.)

(Pl. XLI., fig. 2.)

Length of head contained six times in total length (without caudal) and equal to distance between gill opening and anus. Eye large, diameter contained twice in snout, and five times in length of head. Angle of gape behind hinder margin of eye. Upper jaw slightly overhanging lower; snout broad, swollen, except where produced anteriorly into a short knob-like deflected process, at base of which is situated anterior nostril. Lower jaw slightly curved. Teeth in two rows, outer most closely set, along margin of upper jaw, small and conical posteriorly, becoming larger and recurved in anterior region. Large abruptly reflected teeth, with swollen bases, in several rows on vomer, those of central region largest. A single row of small recurved teeth on mandibles, becoming larger towards symphysis.

Body laterally compressed: greatest height, *i.e.* behind anus, nearly half length of head. Abdominal cavity extending beyond anus; peritoneum black; air-bladder long. Tail tapering, but terminating obliquely. Extremity of vertebral column not upturned, overlying triangular hypural mass. Vertical fins rather feeble, especially dorsal, which commences at a point somewhat posterior to median. Vertical fins edged with black, especially caudal and anal.

Coloration, uniform sepia brown, darkest ventrally, and on snout and jaws.

A single specimen, 5 inches, much injured, from 144 fathoms. It appears to be sexually immature.

ALPHABETIC LIST OF SPECIES.

	PAGE
Acanthias vulgaris,	371
Aphia pellucida,	421
Argentina sphyræna,	509
Arnoglossus Grohmanni,	505
Arnoglossus laterna,	488
Brosmius brosme,	449
Callionymus lyra,	423
Callionymus maculatus,	425
Capros aper,	413
Carelophus Ascanii,	416
Centrophorus squamosus,	372
Chimœra monstrosa,	368
Conger vulgaris,	510
Cottus quadricornis,	414
Crystallogobius Nilssonii,	422
Echeneis remora,	413
Gadus æglefinus,	429
Gadus argenteus,	434
Gadus Esmarkii,	431
Gadus merlangus,	429
Gadus morrhua,	429
Gadus poutassou,	430
Galeus vulgaris,	370
Gobius Friesii,	417
Gobius Jeffreysii,	420
Haloporphyrus eques,	446
Hippoglossoides platessoides,	478
Hippoglossus vulgaris,	478
Hoplostethus mediterraneum,	412
Lepidopus caudatus,	412
Liparis vulgaris,	415
Lophius piscatorius,	415
Macrurus æqualis,	463
Macrurus cœlorhynchus,	451
Macrurus lævis,	472
Macrurus rupestris,	455
Merluccius vulgaris,	445
Molva vulgaris,	448
Mora mediterranea,	436
Motella cimbria,	449
Motella tricirrata,	449
Nettophichthys retropinnatus,	511
Phycis Aldrichii,	446
Phycis blennioides,	445
Pleuronectes cynoglossus,	506
Pomatomus telescopium,	405
Pristiurus melanostoma,	371
Raia batis,	385
Raia blanda,	395
Raia circularis,	394
Raia fullonica,	391
Raia maculata,	403
Raia microcellata,	392
Raia oxyrhynchus,	386
Rhombus Boscii,	486
Rhombus megastoma,	481
Rhombus norvegicus,	484
Schedophilus medusophagus,	414
Scorpæna dactyloptera,	409
Scyllium canicula,	370
Solea Greenii,	508
Solea variegata,	508
Solea vulgaris,	507
Trachypterus arcticus,	416
Trichiurus lepturus,	413
Trigla cuculus,	414
Trigla lyra,	415

PLATE XXXIX.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND, 1890–1891.

EXPLANATION OF PLATE XXXIX.

Figure

1. *Haloporphyrus eques*, Günther (p. 446).

   Small specimen, first dorsal fin-ray moderately extended, but complete. Barbel not visible.

2. *Haloporphyrus eques*, Günther (p. 446).

   Large specimen, first dorsal fin-ray incomplete. Skin of head somewhat shrunken where muciferous cavities occur.

3. *Mora mediterranea*, Risso (p. 486).

Plate XXXIX.

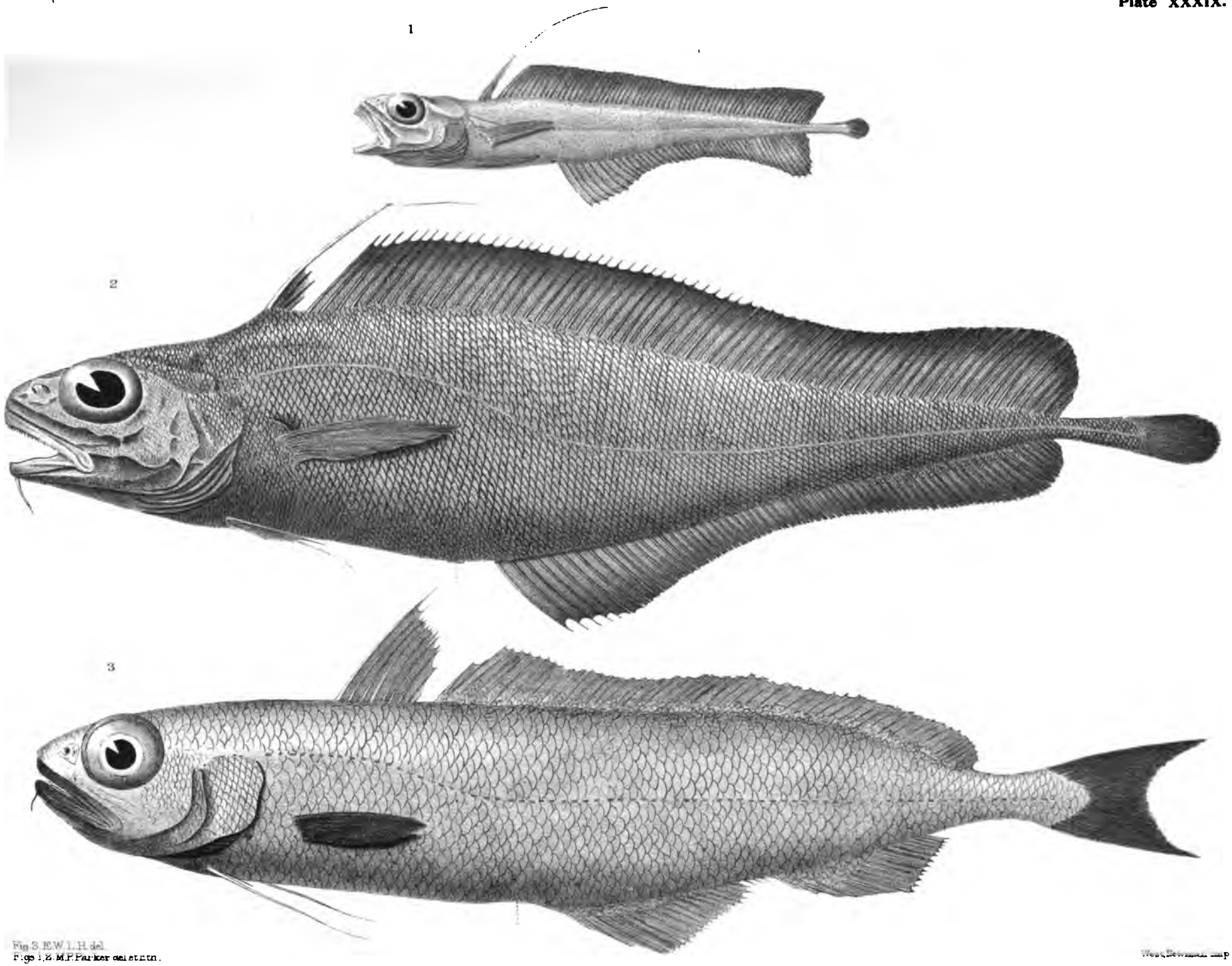


Fig 3. E.W.L.H. del.
Figs 1,2. M.P.Parker del et lith.

West, Newman, imp

PLATE XL.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890-1891.

EXPLANATION OF PLATE XL.

Figure

1. *Macrurus æqualis*, Günther (p. 468).

1*a*. Scale of same, the spinelets shorter and more conical than is the case in scales from young examples.

2. *Macrurus cælorhynchus*, Risso (p. 451).

2*a*. Scale of same, adult condition.

3. *Macrurus lævis*, Lowe (p. 472).

3*a*. Scale of same, adult condition.

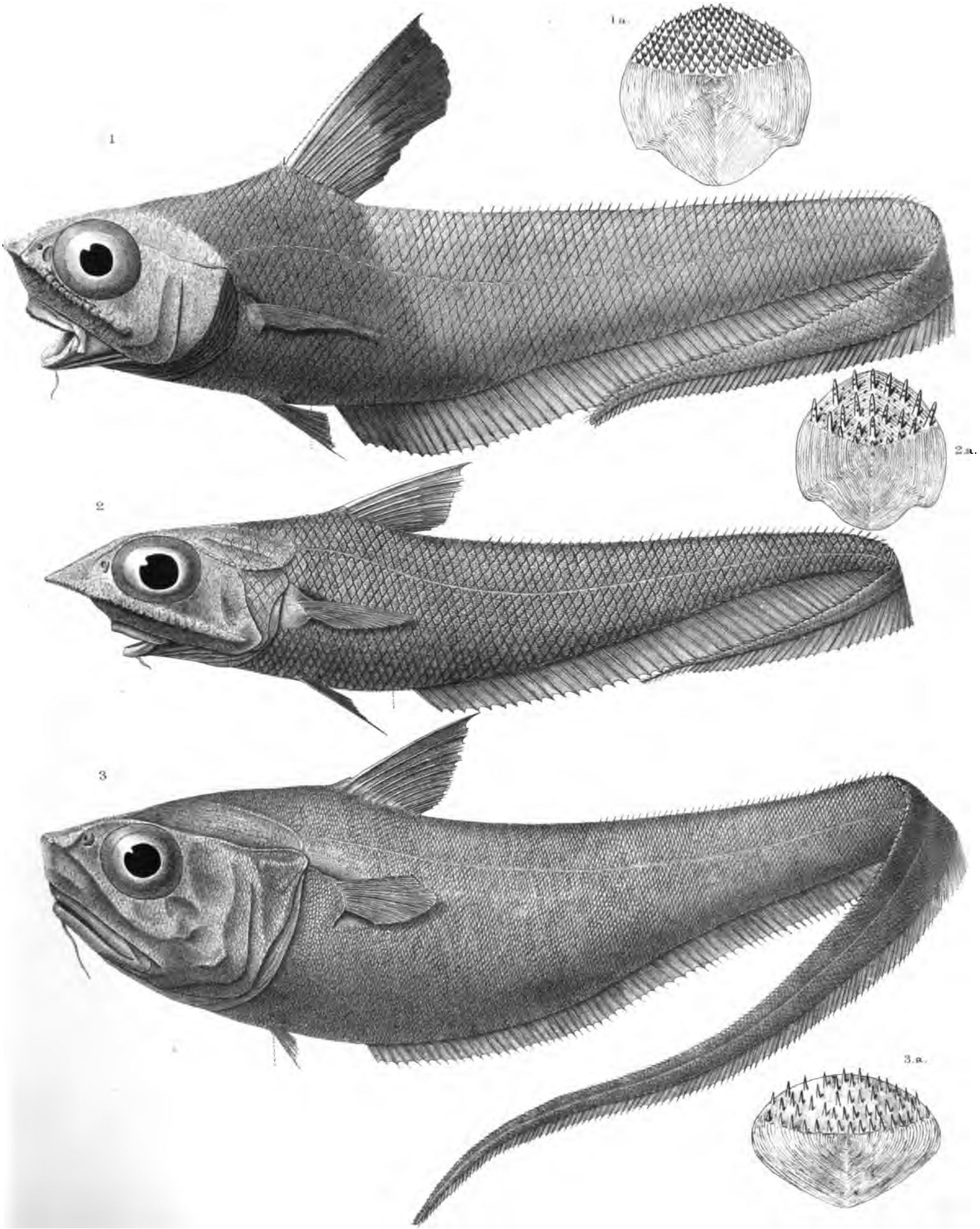

1a.
1
2a.
2
3
3.a.

PLATE XLI.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890-1891.

EXPLANATION OF PLATE XLI.

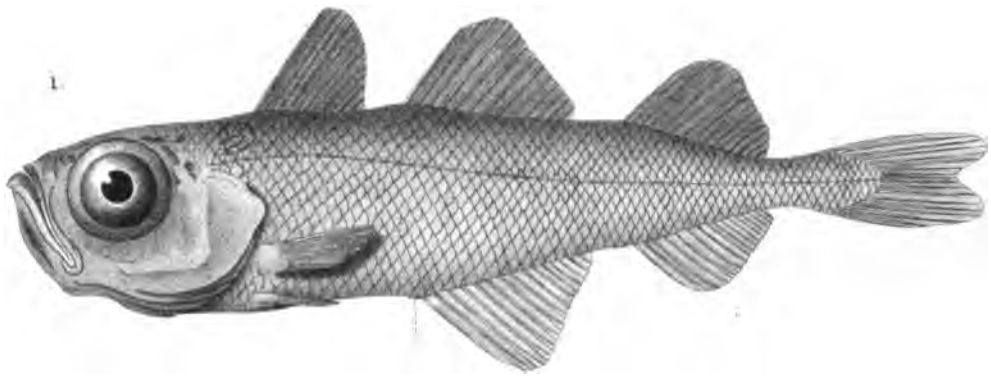
Figure

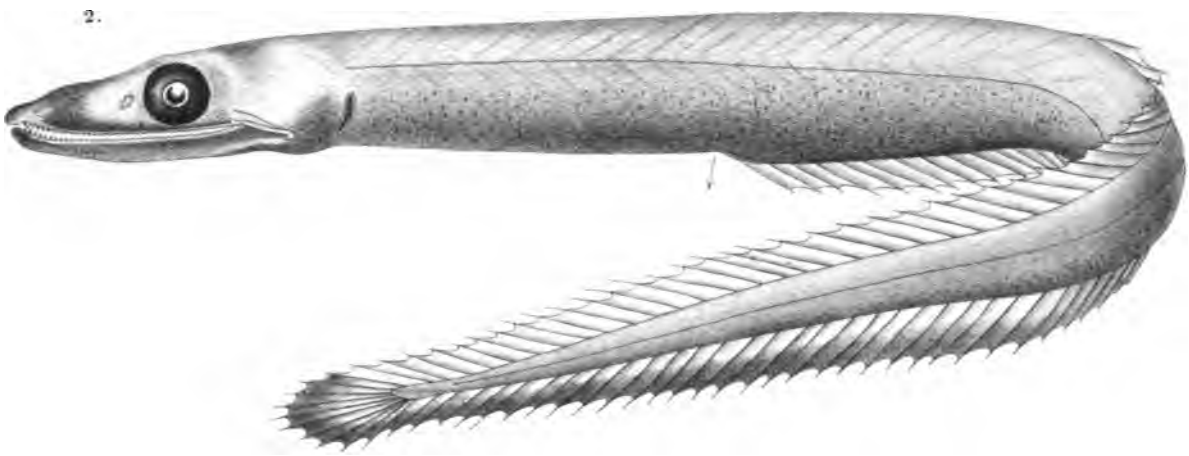
1. *Gadus argenteus*, Guichenot (p. 484).

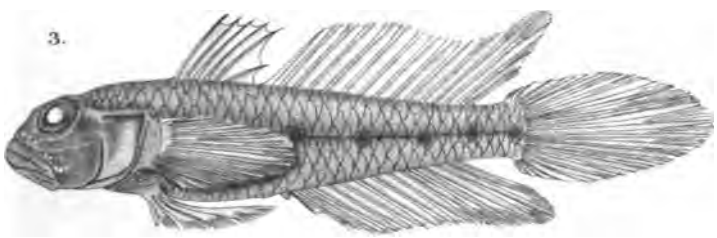
1*a*. View of the superior surface of an adult head, showing the arrangement of the muciferous cavities: *m. c.*

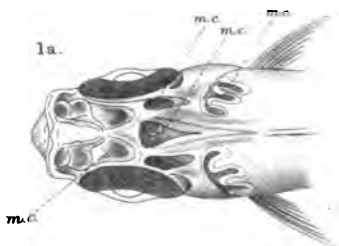
2. *Nettophichthys retropinnatus*, Holt (p. 511).
Type specimen.

3. *Gobius Friesii*, Malm. (p. 417).









West, Newman, im

L.L.L.H.fig.3. coetera E.W.L.H.del.
M.P.Parker lith.

PLATE XLII.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890–1891.

EXPLANATION OF PLATE XLII.

Figure

1. *Scorpaena dactyloptera*, Delaroche (p. 409).

   Adult example. The figure is in error, in that the rays of the lower portion of the pectoral fin are represented as being joined by membrane (a condition only found in young examples); and also in showing scales in the region of the suborbital ridge.

2. Outline of the head of *Sebastes norvegicus*.

1*a* and 2*a*. Sections through the interorbital regions of Scorpaena (1*a*) and Sebastes (2*a*), showing difference of configuration.

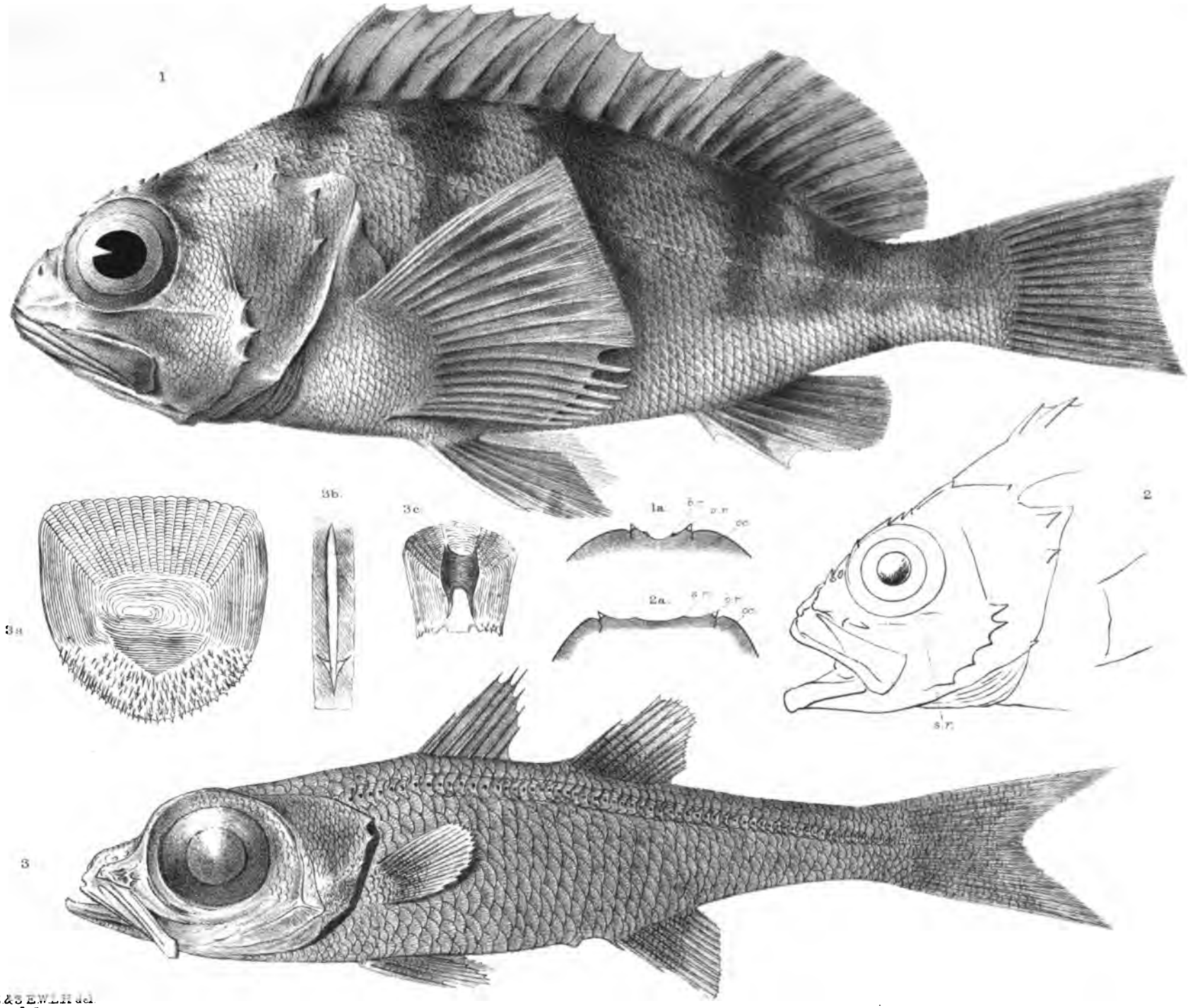
   b. r. . . . bony ridges.
   o. r. . . . orbital ridges.
   oc. . . . eye.

3. *Pomatomus telescopium*, Risso (p. 405).

3*a*. Typically ctenoid scale of same, from central region of body, showing spinous exposed surface.

3*b*. Spine of scale much magnified.

3*c*. Scale from lateral line.



Figs. 1a 2 & 3 E.W.L.H. del.
M.P. Parker lith.

West, Newman imp.

PLATE XLIII.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890–1891.

EXPLANATION OF PLATE XLIII.

Figure

1. *Centrophorus squamosus*, Gm. Linn. (p. 372).

1*a*. Lateral view of one of the pedunculate, keeled scales, taken from central region of body.

1*b*. Surface view of same, showing denticulate margins, and their variation.

2. *Macrurus rupestris*, Gunner (p. 455).

The anterior profile moderately oblique, and snout somewhat obtuse, as in ordinary type

1

1a

1b

2

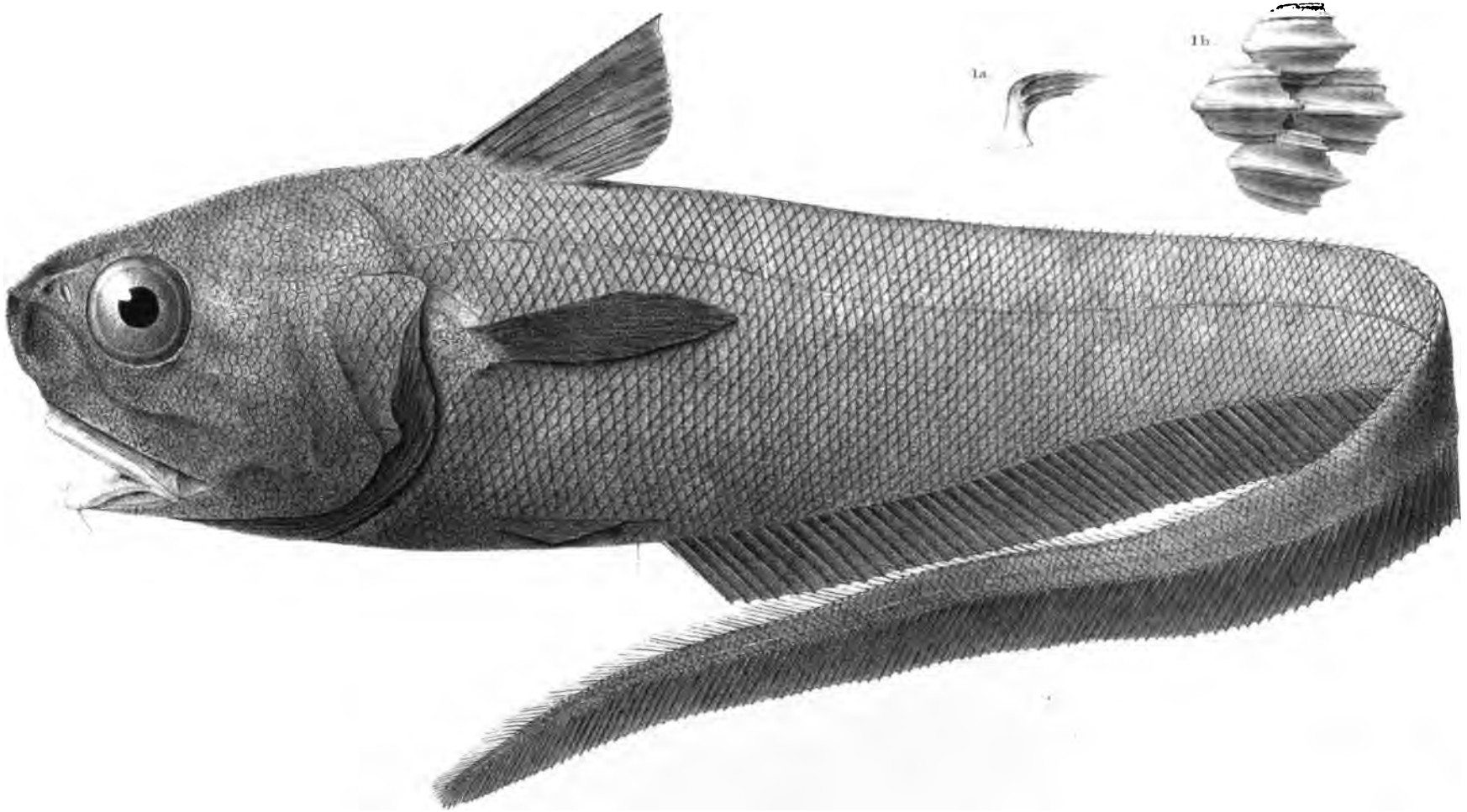


PLATE XLIV.

SURVEY OF FISHING-GROUNDS, WEST COAST OF IRELAND, 1890-1891.

EXPLANATION OF PLATE XLIV.

Mora mediterranea, Risso (p. 486).

A. Dissection of the right side, to show the arrangement and extent of the swimming-bladder, in relation to the viscera and vertebral column.

B. Diagrammatic plan of the swimming-bladder, as seen from above.

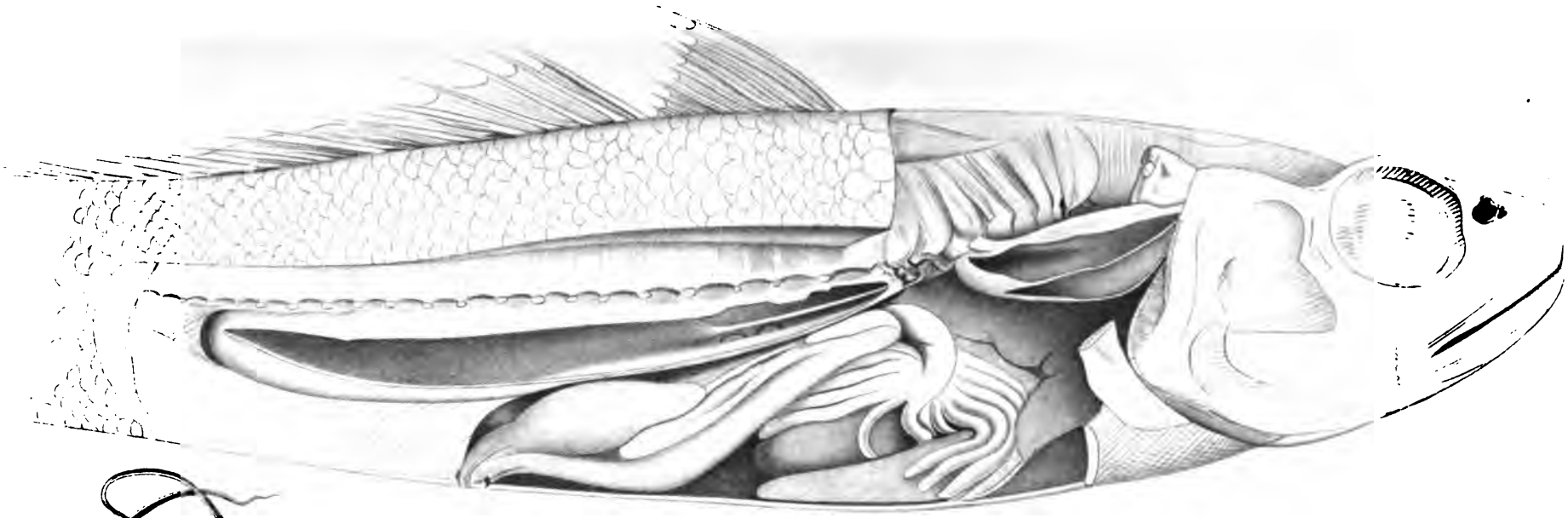
Four egg-cases of *Batoidei* (pp. 892 *et seq.*)—

I. of *Raia blanda*, 18·6 cm. × 7·6 cm. Parent fish measuring 46 inches in extreme breadth.

II. of *Raia maculata*, 6·7 cm. × 4·8 cm. Parent fish measuring 28½ inches in extreme breadth.

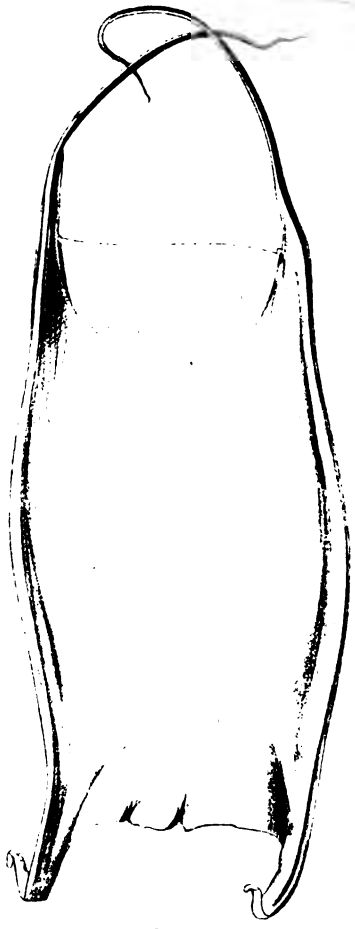
III. of *Raia circularis*, 6·8 cm. × 8·8 cm.

IV. of *Raia microcellata*, 9–10 cm. × 5·7 cm. Parent fish 34 inches in extreme length, and 23¾ inches across the disc.

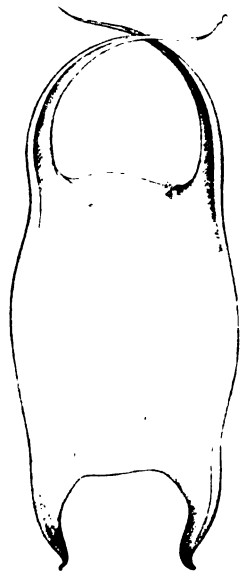


A

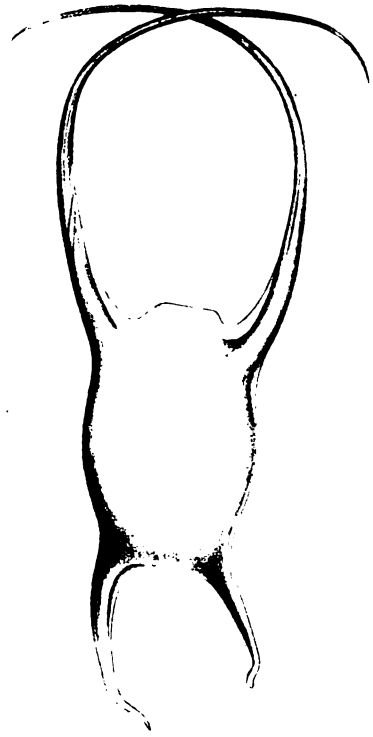
A'



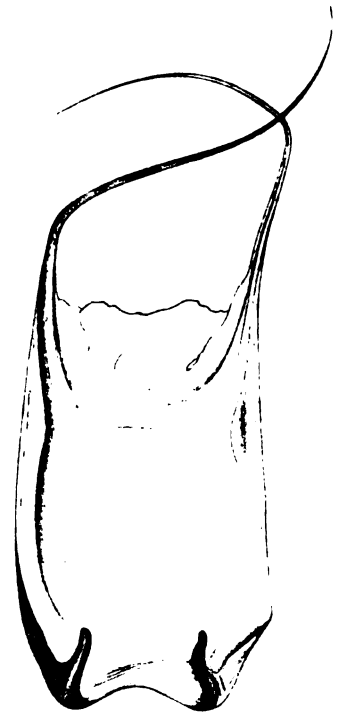
I



II



III

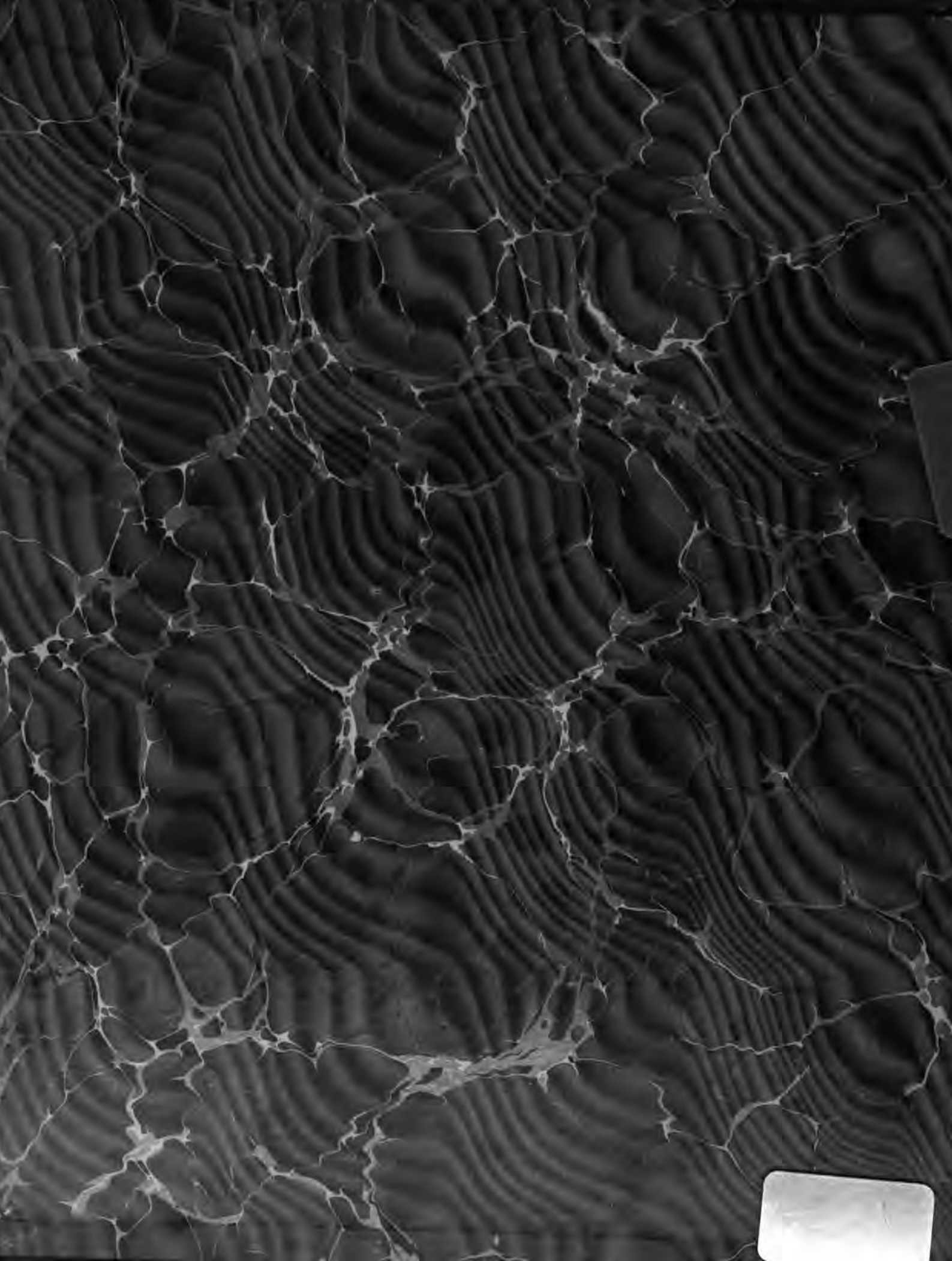
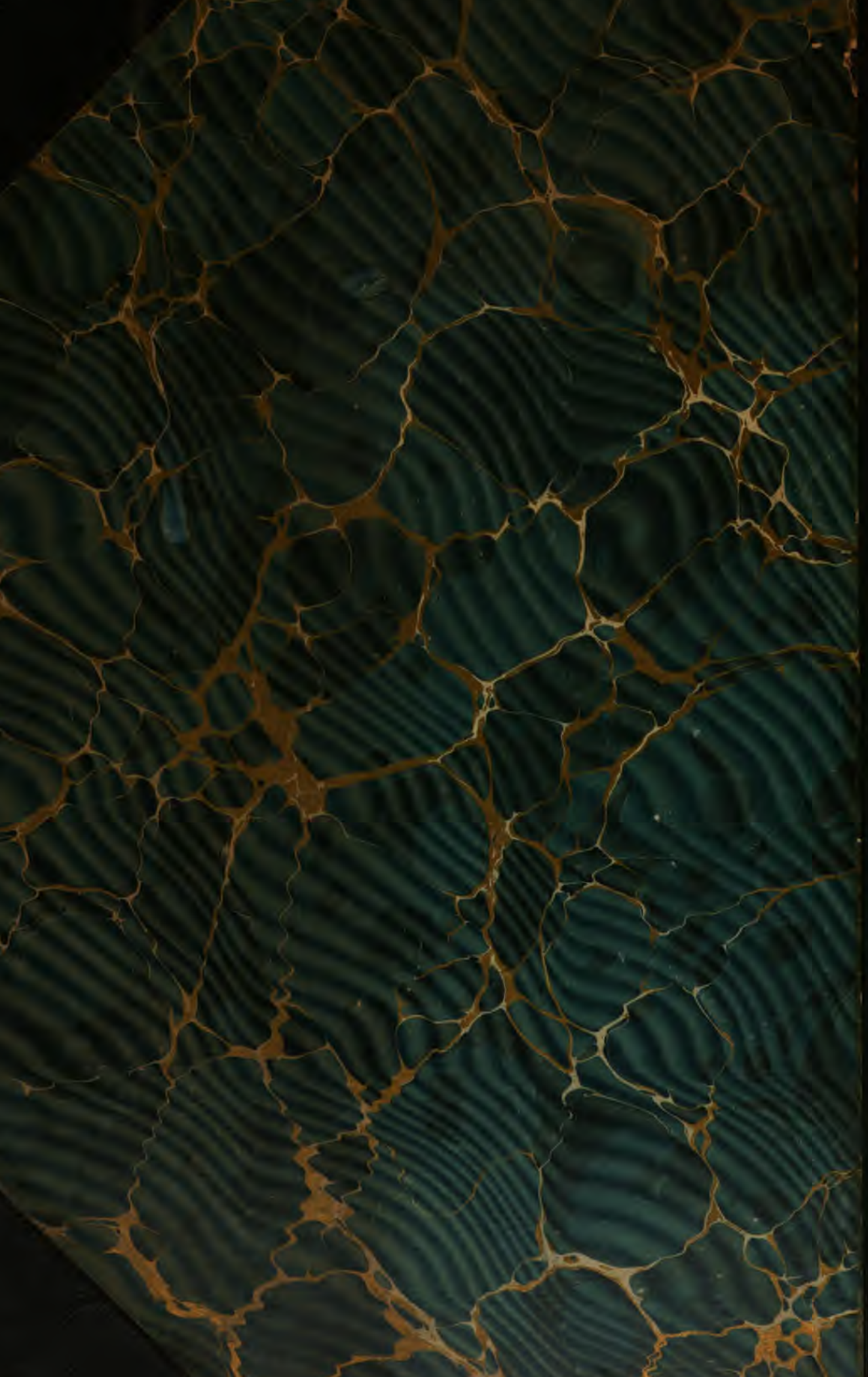


IV

TRANSACTIONS (NEW SERIES).

Vol. I.—Parts 1–25.—November, 1877, to September, 1883.
Vol. II.—Parts 1–2.—August, 1879, to April, 1882.
Vol. III.—Parts 1–14.—September, 1883, to November, 1887.
Vol. IV.—Parts 1–14.—April, 1888, to November, 1892.

VOLUME V.

Part

1. On the Germination of Seeds in the absence of Bacteria. By H. H. Dixon, B.A. (May, 1893.) 1*s.*
2. Survey of Fishing Grounds, West Coast of Ireland, 1890–1891: On the Eggs and Larval and Post-larval Stages of Teleosteans. By Ernest W. L. Holt, Assistant Naturalist to the Survey. Plates I. to XV. (July, 1893.) 8*s.* 6*d.*
3. The Human Sacrum. By A. M. Paterson, M.D., Professor of Anatomy in University College, Dundee (St. Andrews University). Plates XVI. to XXI. (December, 1893.) 4*s.* 6*d.*
4. On the Post-Embryonic Development of Fungia. By Gilbert C. Bourne, M.A., F.L.S., Fellow of New College, Oxford. Plates XXII. to XXV. (December, 1893.) 2*s.*
5. On Derived Crystals in the Basaltic Andesite of Glasdrumman Port, Co. Down. By Grenville A. J. Cole, M.R.I.A., F.G.S., Professor of Geology in the Royal College of Science for Ireland. Plate XXVI. (August, 1894.) 1*s.*
6. On the Fossil Fish-Remains of the Coal Measures of the British Islands. Part II.—Acanthodidæ. By the late James W. Davis, F.G.S., F.L.S., F.S.A., &c. Plates XXVII., XXVIII., XXIX. (August, 1894.) 1*s.*
7. Eozoonal Structure of the Ejected Blocks of Monte Somma. By Prof. H. J. Johnston-Lavis, M.D., M.R.C.S., B-ÈS-SC., F.G.S., &c., and J. W. Gregory, D.SC., F.G.S. Plates XXX. to XXXIV. (October, 1894.) 1*s.* 6*d.*
8. The Brain of the Microcephalic Idiot. By D. J. Cunningham, M.D., D.C.L. (Oxon.) D.SC., F.R.S., Professor of Anatomy, Trinity College, Dublin, Honorary Secretary, Royal Dublin Society; and Telford Telford-Smith, M.D., Superintendent of the Royal Albert Asylum, Lancaster. Plates XXXV. to XXXVIII. (May, 1895.) 3*s.*
9. Survey of Fishing-Grounds, West Coast of Ireland, 1890–1891. Report on the Rarer Fishes. By Ernest W. L. Holt, and W. L. Calderwood, F.R.S.E. Plates XXXIX. to XLIV. (September, 1895.) 8*s.*
10. The Papillary Ridges on the Hands and Feet of Monkeys and Men. By David Hepburn, M.D., M.C., F.R.S.ED., Lecturer on Regional Anatomy, and Principal Demonstrator of Anatomy, in the University of Edinburgh. [From the Anthropological Laboratory, Trinity College, Dublin.] Plates XLV. to XLIX. (September, 1895.) 1*s.* 6*d.*
11. The Course and Nature of Fermentative Changes in Natural and Polluted Waters, and in Artificial Solutions, as Indicated by the Composition of the Dissolved Gases. (Parts I., II., and III.) By W. E. Adeney, Assoc. R.C.Sc.I., F.I.C., Curator and Ex-Examiner in Chemistry in the Royal University, Ireland. (September, 1895.) 3*s.* 6*d.*